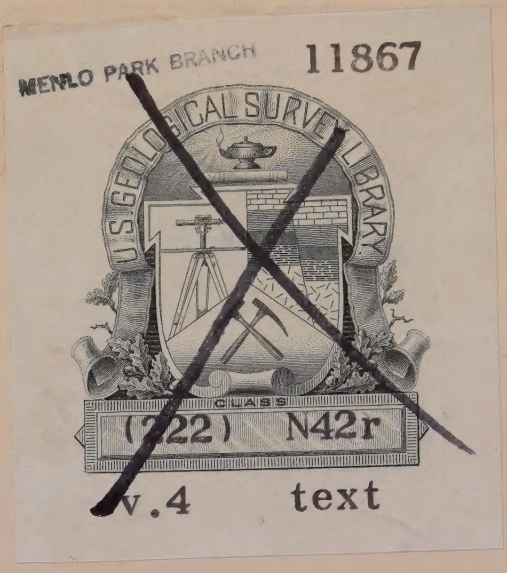
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HENRY B. KÜMMEL, State Geologist

[Report on paleontology
V. 4

A REPORT

ON THE

Cretaceous Paleontology of New Jersey

BY

STUART WELLER

Based upon the Stratigraphic Studies

OF

GEORGE N. KNAPP

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* Died April 19th, 1907.
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To His Excellency Edward C. Stokes, Governor of the State of New Jersey and ex-officio President of the Board of Managers of the Geological Survey:

SIR—I have the honor to submit herewith a report upon the fossils contained in the Cretaceous formations of New Jersey. These formations are better developed in New Jersey than in any State on the Atlantic Coast, and our section has, for a long time, been regarded by all geologists as one of great importance. This report is a complete summary of our knowledge of the forms of life which existed in the seas where these beds were laid down. It differs from some reports published by this department, in that it is purely scientific and does not have the important economic bearing which has characterized most of the publications of the Survey, but since it is a valuable contribution to science, I recommend its publication. It forms a part of my Annual Report for 1906, but because of its technical character I request that it be issued separately from the other papers of said report.

Respectfully submitted,

HENRY B. KÜMMEL,

State Geologist.

TRENTON, N. J., March 26, 1907.

PREFACE.

The invertebrate Cretaceous fossils of New Jersey were among the first fossils of any kind in America to attract the attention of students. As early as 1834 Morton's "Synopsis of the Organic Remains of the Cretaceous Group of the United States" was published in its final form, a large portion of the material he studied having been collected in New Jersey. Even earlier than this the same author had published several preliminary papers. During the period between 1850 and 1876 these New Jersey fossils were diligently studied and many new species described by both Conrad and Gabb, two of the eminent American paleontologists of that period, and a few forms were described by Lea. The collections made and studied by these earlier investigators were for the most part preserved in the museum of the Philadelphia Academy of Science, where they still remain. Unfortunately, in those earlier days, the importance of preserving exactly the localities and geologic horizons of fossils was not appreciated as it is today, and most of the specimens in these early collections are recorded simply from the Cretaceous of New Jersey.

After the organization of the Geological Survey of New Jersey under the direction of the late Dr. George H. Cook, more or less extensive collections of fossils from the Cretaceous beds of the State were accumulated, but the data with these collections was in many cases also unsatisfactory, largely because of the lack of differentiation at that time of the strata of the "clay marl" series. Under the direction of Dr. Cook a study of the New Jersey Cretaceous fossils was undertaken by Prof. R. P. Whitfield, who published a monograph on the Cretaceous and Eocene Mollusca of the State. This work appeared in two volumes, the first in 1886, and the second in 1892, published jointly by the

Geological Survey of New Jersey and the U. S. Geological Survey. In the preparation of these volumes Prof. Whitfield labored under great disadvantages in the way of collections. He was dependent entirely upon the collections already made, chiefly those of the Philadelphia Academy of Science, the State Geological Survey, and the Museum of Rutgers College, no new collections being made especially for his work. Whitfield's monographs, however, have been of inestimable value for the reason that in them descriptions of all the species of earlier authors, originally published in many scattered papers which were inaccessible to the larger number of students, were assembled, and with them many new forms described. The weakness of Whitfield's work lies in the lack, in a large number of cases, of a record of the true stratigraphic position of the species discussed, large numbers of the forms recorded from the "lower marl" being in reality from some one of the formations of the "clay marl" series. The author of the monographs, however, was in no way responsible for this lack, since the necessary stratigraphic data were not furnished him with the collections upon which his work was based.

The present report on the invertebrate fossils of the New Jersey Cretaceous formations consists of two parts. Part I is a discussion of the stratigraphic paleontology of the region, being based upon very extensive collections made in the field by the writer during the field seasons of 1903 and 1904. Accurate data have been secured with all these collections which in the aggregate are much more extensive than all previous collections from the region combined. A large portion of all the species previously described from the region have been detected, besides many hitherto unrecognized ones. It is believed that this portion of the report will not only be of value in the further study of the stratigraphy and paleontology of the region, but also will be useful in future correlation studies of the American Cretaceous, especially that of the Atlantic and Gulf border regions.

Part II of the report is devoted to the Descriptive Paleontology, and is in large part a revision of Whitfield's work in the light of the more extensive collections available and of our more

accurate knowledge of the stratigraphy of the region. This part of the report, however, is not confined to the Mollusca and Brachiopoda as was Whitfield's monograph, but contains also, descriptions of the other invertebrate groups. The chapter on the Protozoans has been compiled from Bagg's work on the New Jersey Cretaceous Foraminifera.[1] The chapter on the Echinoids also is strictly a compilation from Clark's report on the Mesozoic Echinodermata,[2] to which has been added the descriptions of several new forms, generously furnished by Dr. Clark.

In comparing the faunas of these New Jersey Cretaceous beds with similar faunas elsewhere, the condition of preservation of the New Jersey specimens has been a serious obstacle. Many of the New Jersey species are known only in the condition of internal casts while the species from the Southern States have mostly been described from specimens preserving the shells. The recent collections, however, have afforded many species with the shell preserved and in addition to these the external impressions of the shells have frequently been secured, from which plaster casts or wax squeezes have been obtained which have given the external characters of the shell.

In many of the more or less incoherent beds of the region the shells have been removed by solution, after which the cavities left by them have been closed by pressure, the resultant specimens being somewhat modified internal casts with the markings of the exterior of the shell impressed upon them. At first it was found to be difficult to preserve such material because of its incoherent nature, the specimens crumbling more or less easily on becoming thoroughly dry. This difficulty has been obviated, however, by carefully cleaning the material while still moist, soon after being removed from the ground, then, after being thoroughly dried, with very careful handling, the specimens have been immersed in molten paraffin for from 40 minutes to one hour. On cooling after removal from the paraffin, these specimens have proved to be in excellent condition for permanent preservation. Other specimens preserving the shell itself in a

[1] Bulletin U. S. G. S. No. 88.
[2] Bulletin U. S. G. S. No. 97.

soft and friable condition have been given the same treatment with most satisfactory results. In immersing the specimens in the paraffin a wire basket has been found most convenient. They have been carefully arranged in this basket to be lowered into the vessel containing the molten paraffin, then after having been allowed to remain in the paraffin for a sufficient length of time they can be removed without injury, to be spread out to cool and harden.

During the preparation of the report it became desirable to make more careful comparisons of the material than could be done from the literature alone, with species of similar age from the Gulf border states. For the opportunity to make such comparative studies I am under great obligation to Dr. T. W. Stanton of the U. S. Geological Survey, who allowed me unlimited access during an entire week to the extensive collections made by himself and preserved in the U. S. National Museum, from the Upper Cretaceous of the Gulf border region. To Dr. H. A. Pilsbry, of the Philadelphia Academy of Science, I am also greatly indebted for the courteous manner in which he gave me every facility for examining and studying the collections from the New Jersey Cretaceous preserved in the museum of the Academy. Through his coöperation also, and that of Dr. Gilbert van Ingen, it has been possible to reproduce in the plates many of Whitfield's types which are in that museum. These collections have been of special value in connection with the work, containing as they do the larger number of types of species described by the earliest workers in the field. Prof. J. V. Lewis, of Rutgers College, has also most generously placed the numerous types of species described by Whitfield, preserved in the museum of the college, in my hands for study and comparison. For assistance in the preparation of the chapter on the Bryozoans from the Vincentown limesand I am profoundly indebted to Dr. R. S. Bassler of the U. S. National Museum. All the identifications of these forms were made by Dr. Bassler with the assistance of Dr. E. O. Ulrich of the United States Geological Survey, all the new species were recognized by them, and notes on their characteristics furnished the writer for use in the pre-

paration of the descriptions. The excellent photographs, also, illustrating these Bryozoa were prepared by Dr. Bassler or under his immediate supervision. For the preparation of descriptions and illustrations of the new species of Echinoids, I am under obligation to Dr. W. B. Clark. The crinoidal element in the faunas studied is meager, a single new form having been observed, but for suggestions as to the relationship of this form I am indebted to Dr. Frank Springer. To Mr. J. M. Manley, of New Brunswick, I am indebted for the specimens of *Corbula manleyi* from the Raritan formation; invertebrate remains are exceedingly unusual in this formation, and Mr. Manley deserves great credit as a collector for discovering this form. Also to Mr. G. N. Knapp, I wish to express my obligation. Mr. Knapp's wonderfully detailed knowledge of the Cretaceous formations of New Jersey has been of inestimable value to me during the prosecution of the field work, in assisting me to find the best fossil localities without loss of time. To Dr. H. B. Kümmel, the State Geologist, I am under lasting obligations for the continued interest he has shown in the work, and for the encouragement he has continually given during its prosecution.

Chicago, Dec. 1st, 1906.

PART I.

Stratigraphic Paleontology.

CHAPTER I.

INTRODUCTION.

The Cretaceous formations of New Jersey occupy a belt running diagonally across the State in a northeast-southwest direction, from the shores of Raritan Bay and the Atlantic Ocean at the north, to Salem County in the south, the southernmost two-thirds of the belt being parallel with the Delaware River below its sharp bend at Bordentown. This belt has its greatest width of about 25 miles at the northeast, where it extends from Woodbridge to Asbury Park. Southeast of Trenton the width of the belt is about 18 miles, but beyond Bordentown it is abruptly narrowed and continues to the western edge of Salem County with an average width of less than 10 miles. The strata slope to the southwest with an average dip of about 20 feet to the mile, and there are no structural features to obscure the stratigraphic relations of the beds.

The stratigraphy of this Cretaceous belt was first studied by Cook,[1] who divided the entire succession of beds into three series, called by him the "plastic clay" series, the "clay-marl" series and the "marl" series. These three divisions are practicable even to-day, but the more critical geological investigations of the present time demand a more refined classification of the strata than that used by Cook, especially for his "clay-marl" series. Cook's classification was based exclusively upon the lithologic and economic characters of the beds, and since, at the time his investigations were being prosecuted, marl digging was an important industry in a portion of this Cretacious area, he gave far more attention to the discrimination of the subdivisions of the "marl" series than to those of the subjacent "clay-marl" series. Cook's understanding of the

[1] Geol. N. J., 1868, pp. 241–283.

stratigraphy of the "marl" series, at least in Monmouth County, was so exact that more recent investigations have not made it necessary to change his subordinate divisions of this series in any essential respect, although he did fall into errors in the interpretation of some of the beds in their southwestern extension in Gloucester and Salem counties. Cook's subdivision of the "clay-marl" series into the "clayey green sand" below and the "laminated sands" above, is of little or no utility at the present time, but his divisions of the "plastic clay" series, so far as it occurs in Middlesex and Monmouth counties cannot be much improved upon even to-day. A tabular view of Cook's divisions is shown in table I.

The more recent investigations of the stratigraphy of the Cretaceous formations of New Jersey have been conducted by Dr. W. B. Clark, Mr. G. N. Knapp and Dr. H. B. Kümmel, all working more or less independently.

Clark began his study of the region in 1891, the results of his work being published in the Annual Reports of the Survey for 1892, 1893 and 1897. The subdivisions which he recognized were not essentially different from those of Cook, but instead of the lithologic names used by Cook, geographic terms were used for the designation of the formations, and in his later publications he did not repeat the error which Cook made regarding the southwest extension of the Red Sand and Lower Marl.

Table II shows these subdivisions in a tabular form.

All the geographic formation names used by Clark were original with him except Raritan. This name had first been applied to the lowermost division of the New Jersey Cretaceous by Conrad[1] in 1869, but without any definite statement as to the upper limits of the formation. Since that time the name has been frequently used by various authors, but has usually been applied to the clay beds so extensively worked near the Raritan River. Clark was, perhaps, the first to assign a definite upper limit to the series in applying the name to the whole succession of beds beneath the "clay-marl" series of Cook, or the Matawan formation as it was called by Clark himself, except the lignitic

[1] Am. Jour. Sci., 2d Ser., vol. 47, p. 360.

TABLE I.

Table Showing Cook's Interpretation of the Stratigraphy of the New Jersey Cretaceous.

Marl Series.	Upper Marl.	Ash Marl. Green Marl.
	Yellow Sand.	
	Middle Marl.	Yellow Limestone and Limesand. Shell Layers. Green Marl. Chocolate Marl.
	Red Sand.	Indurated Green Earth.
		Red Sand. Dark Micaceous Clay.
	Lower Marl.	Marl and Clay. Blue Shell Marl. Sand Marl.
Clay-Marl Series.		Laminated Sands. Clayey Green Sand.
Plastic Clay Series.		Lignite. Potter's Clays. Fire Clay.

TABLE II.

Table Showing Clark's Interpretation of the Stratigraphy of the New Jersey Cretaceous, with Cook's Equivalents.

Manasquan.	Manasquan Marl = { Ash Marl. Green Marl.
	Yellow sand, later referred to Miocene.
Rancocas	Vincentown limesand = { Yellow limestone. Limesand.
	Sewell Marl = { Shell Layers. Green Marl. Chocolate Marl.
Monmouth.	Red Bank Sand = "Red Sand."
	Navesink Marl = "Lower Marl" in part.
	Mount Laurel Sand = "Sand Marl."
Matawan.	Hazlet Sand = "Laminated Sand."
	Crosswick Clay = "Clayey Green Sand."
Raritan.	

clays on the south shore of Raritan Bay, making the name Raritan nearly the equivalent of Cook's "plastic clay" series.[1]

Knapp's study of the Cretaceous was carried on in connection with work on the Pleistocene formations. The progress and results of that work are briefly given in the following paragraphs, which have been prepared by him.

BY G. N. KNAPP.

Early in the work on the Pleistocene formations it was found necessary to make a careful study of and to map the subjacent Cretaceous beds in order to differentiate some of them from the Pleistocene sands, which they closely resembled. Beginning in April, 1894, the Cretaceous formations were, therefore, mapped from Crosswicks Creek southwest to Rancocas Creek. In 1895 the work was continued southwest from Rancocas Creek to Salem, and in 1896 the mapping was carried northeast from Crosswicks Creek across Monmouth County to Asbury Park and Atlantic Highlands. In 1900-1903 the detailed mapping was revised, and the lines delimiting the Cretaceous formations were more accurately fixed.

In 1894, when this work was begun, the only comprehensive description of the New Jersey Cretaceous was that by Cook,[2] and the only geological maps available were those accompanying the 1868 Report (scale 2 miles per inch) and the various State Geological maps on the scale of 5 miles per inch. Dr. Clark had begun work on the Cretaceous in New Jersey in 1891, and the State Geologist's Report for 1892 contained a report of progress of his work and a preliminary map of the Cretaceous in Monmouth County. A second report of progress by Dr. Clark was contained in the Annual Report for 1893, which was issued during the summer of 1894, after the writer had commenced his mapping in Burlington County. The classification then proposed by Dr. Clark was not entirely in accord with the writer's observations in the region southwest of that in which most of Clark's

[1] Geol. Surv. N. J., Ann. Rep. of the State Geol. for 1892, p. 181; Ibid. for 1893, p. 335.

[2] Geology of New Jersey, 1868, and Annual Report for 1886.

work had been done, and he, therefore, continued his work on the Cretaceous in connection with the Pleistocene mapping. The chief points of difference were, first, the subdivision of Cook's "clay-marl" series, for which Clark proposed the name Matawan, and, second, the proper position of a bed of marl and the overlying sand in the region south of Rancocas Creek, which Cook had erroneously regarded as the Lower Marl and Red Sand, respectively, and in which conclusion he was at that time followed by Clark. At a later period the writer was also led to differ with Clark regarding the position of the so-called "yellow sand" of Monmouth County.

In the valley of Crosswicks Creek, near Walnford, the writer had found a fossil bed, 1 to 2 feet thick, in which fossils *Gryphaea convexa* and *Belemnitella* were particularly abundant. It occurred at the base of a bed of black and chocolate marl, and at the top of a loose quartz sand, and because of the contrast in the adjoining beds and its induration, it formed a readily recognizable horizon which could be traced for 2 miles or more along the valley sides until its dip carried it below the stream bed. From published reports, this fossil bed was inferred to mark the base of the Lower Marl of Cook, and it became the starting point in differentiating the lower beds.

Between Walnford and Bordentown the "clay-marl" series of Cook below the fossil layer was found to consist of five beds, as follows, beginning at the top: yellow and white quartz sand, considerably micaceous towards its base, 60-70 feet; black marly clay, 40 feet; sand with seams of clay, 30 feet; massive clay, black in deep exposures, chocolate-colored where weathered, 55 feet; and a marly clay, black or greenish-black in fresh exposures and weathering to a peculiar cinamon-brown porous earth, 60 feet. Beneath this last bed occurred lignitic sands and clays, which were regarded as a part of Cook's "plastic clay" (Raritan). For a time these subdivisions were known by numbers, 1 to 5, beginning at the bottom, but when it was found that the same series of beds were repeated in each valley southwest of Crosswicks Creek the following names were substituted in 1895,[1]

[1] They were not used in print, however, until later.—Geol. Surv. of N. J., Ann. Rept. State Geol. for 1898, pp. 3–41.

beginning at the base; Merchantville, Woodbury, Columbus,[1] Marshalltown and Wenonah.

In carrying these subdivisions across the State it was found that some modifications in constitution and thickness occurred. For example, the Wenonah sand which approached 100 feet in thickness in Salem County decreased to about 40 feet at Atlantic Highlands and became finer and more micaceous to the northeast. The Englishtown (Columbus) sand, 100 feet thick at Hazlet in Monmouth County, pinched out in the vicinity of Auburn, Salem County. The Marshalltown bed, while maintaining a nearly uniform thickness, changed from a sandy marl in Salem County to a clay and sand with beds of marl in Monmouth County. The Merchantville and Woodbury beds continued fairly uniform in thickness and constitution across the State.

The shell bed at the base of the Lower Marl was traced in 1894 from Crosswicks Creek to Rancocas Creek near Smithville, and it was also recognized at Mount Holly in the side of the hill just north of the town at an elevation of 105 feet, where the Lower Marl appeared as an outlier. The State Geological map, however, represented these marl beds as part of the Middle Marl (Hornerstown)[2], and the sand which underlay them as the Red Sand (Redbank) of Monmouth County, while the Lower Marl (Navesink) was shown as a bed outcropping at Mount Holly at an elevation much lower than the shell bed. It was apparent that the earlier workers were in error, since the Lower Marl and Red Sand as mapped southwest of Mount Holly were in reality the Marshalltown and Wenonah beds respectively, and could be traced without much difficulty to the section along Crosswicks Creek. To settle this question beyond any doubt, the

[1] The term Columbus as here used has been found to conflict with its prior use in Ohio for a formation of the Devonian, and hence in this report the term Englishtown will be used instead, as the formation is well developed near that place in Monmouth County. [H. B. K.]

[2] This name was used by Knapp in unpublished reports about the same time that the term Sewell was proposed in print by Clark for the same formation. The term Sewell is, however, now abandoned since its application to the Cretaceous of New Jersey has been found to conflict with its prior use in Virginia and West Virginia or beds in the Carboniferous, and Dr. Clark acquiesces in the substitution of the term Hornerstown. [H. B. K.]

Lower Marl (Navesink), Red Sand (Redbank), and Middle Marl (Hornerstown) beds were traced from Crosswicks Creek southwest to Rancocas Creek. It was then found that the Red Sand pinched out 2 or 3 miles southwest of Crosswicks Creek, thus bringing the Lower and Middle Marls in juxtaposition from a point near Jobstown to Salem. Locally, the lithological peculiarities of the Lower Marl were recognizable in the lower part of the combined bed and those of the Middle Marl in its upper portion, but it was not possible to map them as separate beds, and there were some facts which indicated that the Lower Marl became progressively thinner southwest of Marlton, so that more and more of this horizon was made up of the Middle Marl bed.

The mistaken identification of the Marshalltown of the southern district with the Lower Marl northeast of Jobstown naturally led to the erroneous correlation of the Middle Marl, Red Sand and the Wenonah Sand of Crosswicks Creek with the combined Middle and Lower Marl bed, the Wenonah sand and the Englishtown (Columbus) sand, respectively, of Rancocas Creek, and the mistaken correlation was continued on the maps southwest to the Delaware Bay.

That a mistake should have been made in the earlier work is not surprising when it is remembered that accurate topographic maps were not available when the work was done, and that the Marshalltown bed in the southern counties was once dug for marl, and is there much like the Lower Marl (Navesink).

This error of correlation was discovered by the writer as above mentioned in the spring and summer of 1894. In his second report of progress,[1] Dr. Clark very naturally made the same error, since his work up to that time in the region south of Crosswicks Creek had been in the nature of reconnaissance only and had not been sufficiently detailed to reveal the mistake, which was corrected in his report several years later.[2] The repetition of this error in 1893, however, was more unfortunate in that at that time the name Rancocas was proposed (and has been used since by many writers for Cook's Middle Marl and Lime-

[1] Annual Report of the State Geologist for 1893, p. 353 et. seq.

[2] Annual Report of the State Geologist for 1897, p. 184.

sand beds) on the supposition that the whole formation was present in the type locality, but, as determined by the writer about the time the term was first used in print, this is not the case, and the Middle Marl cannot in the type locality be sharply separated from the Lower Marl. As first used in fact the term Rancocas included them both. This gave rise to somewhat misleading descriptions of the Rancocas, as some features characteristic of the Lower Marl were naturally ascribed to it.

The maps published with the Report of 1868, in the region southwest of Mount Holly, show four of the five above-named subdivisions, which the writer differentiated in the Crosswicks section. It is true that the two upper subdivisions were then supposed to be the correlatives of the Red Sand and Lower Marl of Monmouth County respectively, and only the two lower were regarded by Cook as belonging to his "clay-marl" series. The fact, however, that they had been mapped demonstrates that even at that early day the distinctness of these lithologic units was recognized, and it is, therefore, a little surprising that Clark[1] after he had mapped the entire Cretaceous belt in New Jersey, decided to make only three subdivisions (Mount Laurel, Hazlet and Crosswicks) in this interval, and apparently omitted from his classification the Marshalltown marl bed, although it had been mapped by Cook (under the term Lower Marl) so many years before. Clark refers, however, in his description of the Hazlet sand, to a "well-developed dark-colored clay" frequently found at its top, which would indicate that he recognized these beds at some localities.

In Cook's classification, the Middle Marl was made to include a bed of calcareous sand above the greensand bed, although on his early maps this lime-sand bed was represented separately from the marl, but combined with his "yellow sand." The work of the writer in 1894, 1895 and 1896 convinced him that the lime-sand bed was a lithologic unit of importance equal to that of the marl bed below (for which he at that time used the term, Hornerstown), and that this mapping was warranted. These beds were, therefore, carefully traced, and the limesand was found to merge into the "yellow sand" of Monmouth County. In this

[1] Annual Report of the State Geologist for 1897, p. 174 et. seq.

conclusion the writer has been opposed to Clark, who first included the "yellow sand" in the Upper Marl (Manasquan) and later in the Miocene. Weller's paleontological work has confirmed the correctness of its correlation with the limesand, a conclusion in which Clark now joins.

The writer also mapped in detail the occurrence of a bed of indurated marly sand (Tinton), occurring in the upper part of Cook's Red Sand, which previous workers had not separately treated. Owing to its hardness, it is a somewhat conspicuous stratigraphic unit and hence was mapped separately, although its areal extent is somewhat limited.

The correlations and mapping worked out by the writer were based almost entirely upon the physical and lithological character of the beds. Subsequent study of the faunas by Weller has shown that most of these lithologic units are also faunal units, at least of a minor grade. However, in the case of the Wenonah sand, as the writer mapped and described it, the faunal classification does not entirely agree with the lithologic. The writer holds that in this case the economic considerations involved demand that the lithologic classification is the one which should be represented on a geologic map, rather than one based on the less evident and less familiar facts of paleontology.

Somewhat later, in connection with the study of the clays and clay industry in New Jersey, Kümmel[1] studied the stratigraphy of the lower Cretaceous beds of the State, and with Knapp's completed maps in hand examined more or less in detail the higher formations, his observations substantiating in the main those of Knapp. In this report Kümmel grouped the formations in a three-fold division, following Cook in this respect, and indicated that in his opinion, that arrangement was best suited to bring out the lithological and economic characteristics of the New Jersey Cretaceous. The stratigraphy as interpreted by Knapp and Kümmel in that report is shown in the accompanying Table III.

[1] Geol. Surv. N. J., Final Report, vol. vi. (1904.)

TABLE III.

Table Showing Knapp and Kümmel's Interpretation of the Stratigraphy of the New Jersey Cretaceous.

Marl Series.	Upper Marl (in part).
	Limesand (including Yellow Sand.)
	Middle Marl (Sewell).
	Red Sand. (Red Bank Sand.)
	Lower Marl—(Navesink Marl).
Clay-Marl Series.	Wenonah Sand.
	Marshalltown Clay-marl.
	Columbus Sand.
	Woodbury Clay.
	Merchantville Clay-marl.
Clay Series.	Raritan.

In his most recent publication on the subject Clark[1] also has recognized, in the main, the subdivisions of the "clay-marl" as defined by Knapp and Kümmel.

In the earlier discussions and mapping of the New Jersey Cretaceous by Clark, certain beds of more or less lignitic clays at Cliffwood Point and elsewhere along the south shore of Raritan Bay, which are distinctly below Knapp's Merchantville clay-marl, were included in the Matawan formation, while farther south the basal line of the Matawan was drawn to conform strictly with the base of the Merchantville. More recently these Cliffwood beds have been separated by Clark[2] from his Matawan formation and have been considered as representing a distinct formation between the Raritan and the Matawan, to be correlated with the Magothy formation, originally defined by Darton[3] from northeastern Maryland. These beds were by Kümmel[4] included in the Raritan series, that series of strata being made strictly equivalent to the "plastic clay" series of Cook; and in this he was followed by the writer[5] in a discussion of the faunas of the Cliffwood clays. It was noted by Kümmel, however, that at least locally there was an unconformity between one of the lower divisions of the beds referred by him to the Raritan, viz. the Amboy stoneware clay, and the beds above,[6] and further field observations by Berry and Bibbins, seem to show that a fairly definite and mapable line between these stoneware clays and the superjacent beds can be distinguished. Under this interpretation the name Raritan becomes restricted more nearly to its original usage, and those beds lying between that formation and the base of the Merchantville constitute a stratigraphic division which doubtless may be correlated with the Magothy, as was suggested by Clark, and which includes the Cliffwood clays, and the "laminated sands" of Kümmel.[7] In regard to this division of the

[1] Am. Jour. Sci. 4th Ser., vol. xviii, p. 440.
[2] Am. Jour. Sci., 4th Ser., vol. xviii, pp. 435-440.
[3] Am. Jour. Sci., 3d Ser., vol. xlv, pp. 407-419.
[4] Geol. Surv. N. J., Final Rep., vol. vi, p. 166.
[5] Jour. Geol., vol. xiii, pp. 324-337; Geol. Surv. N. J., Ann. Rept. State Geol. for 1904, pp. 133-144.
[6] Loc. cit., p. 169.
[7] Loc. cit., pp. 166-168.

New Jersey Cretaceous, Berry, who has made a careful study of its flora, writes as follows[1]:

"While my work has been more in the nature of a reconnaisance, and not sufficiently detailed for more than tentative conclusions, it would indicate that the Amboy stoneware clay proper marks the upper limit of the Raritan. This reduces the Raritan to a more orderly sequence by simply taking out the variable members that overlie the very much eroded surface of this Amboy stoneware clay. These lower Magothy members, which would then include the laminated sands, are in one place a dark clay, which, within a short distance, may thin out and be replaced by a sugary, somewhat ironstained sand."

Another point in the stratigraphy of this region where there have been differences of opinion is in the relationships of the Mount Laurel sand of Clark and the Wenonah sand of Knapp. Clark recognized at Atlantic Highlands[2] about 5 feet of Mount Laurel sand which was said to increase in thickness to the south to fully 80 feet in the vicinity of Salem. At Atlantic Highlands this formation is essentially the equivalent of Cook's "sand marl" division of the "Lower Marl," and its faunal characters ally it intimately with the overlying marl bed, while in Gloucester and Salem counties it was essentially the whole of Knapp's Wenonah. This bed was considered by Clark as a subordinate division of his Monmouth formation.

The name Wenonah was given by Knapp to the entire sand-filled interval between the "Lower Marl" and the Marshalltown. At Atlantic Highlands the formation comprised 30 or more feet, including the whole of Clark's Mount Laurel sand and the upper portion of his Hazlet sand. To the south the formation thickens and is essentially equivalent with Clark's Mount Laurel. It is seen then that the lower boundary of the Clark's Mount Laurel is, in fact, a line running diagonally across Knapp's Wenonah from near its top at Atlantic Highlands to near its base in the vicinity of Salem, and that the two names are not equivalent. For the correct interpretation of this portion of the section it has been necessary to appeal to paleontologic evidence. There is introduced at about this horizon a peculiar, foreign faunal element which can be recognized more or less continuously across

[1] Geol. Surv. N. J., Ann. Rep. State Geol. for 1905, p. 136.
[2] Geol. Surv. N. J., Ann. Rept. State Geol. for 1897, p. 183.

the State. This faunal element is of such a nature as to make it reasonable to conclude that the position of its introduction in successive sections across the State marks a *contemporaneous horizon*. The first appearance of this faunal element at Atlantic Highlands is at the base of Clark's Mount Laurel sand at that locality. Here there is a slight lithologic difference between the coarse marly sand carrying this faunal element and the finer micaceous sand beneath, so that there is here some lithologic reason for dividing Knapp's Wenonah to accord with the paleontology. At Mullica Hill, in Gloucester County, this faunal element has been found at least 20 feet below the base of the marl bed there shown, and it may occur still lower. With this contemporaneous faunal horizon as a datum line, it is seen that neither the basal boundary of the Mount Laurel nor the upper boundary of the Wenonah, as the beds were originally described, represent contemporaneous horizons across the State. The summit of this sand-filled interval becomes later and later in time in passing from the north to the south because of the longer duration in that direction of the sand-depositing conditions. By limiting the name Mount Laurel to the upper sands containing the new faunal element, as was done by Clark himself at Atlantic Highlands, and the Wenonah to the beds below, which on the whole are finer and quite micaceous, it may be possible to give both these names a place among the Cretaceous formations of New Jersey. If the lithologic distinction between the two horizons was as clear all the way across the State as it is at Atlantic Highlands, this could easily be done and the two formations separately mapped. To the south, however, the lithologic differences become much less distinct, although for much of the distance across the State the lower division of the sand, the Wenonah (using the term in the restricted sense) is slightly finer and more micaceous and clayey, while the upper (the Mount Laurel) is more ferruginous and glauconitic.

Still another point in the stratigraphy of the New Jersey Cretaceous has been given different interpretations by different workers in the field. This is the "yellow sand" near the summit of the section. This formation was given a definite place in the section by Cook between the "yellow limestone" and "limesand"

TABLE IV.

Table showing the present interpretation of the stratigraphy of the New Jersey Cretaceous.

Manasquan
Vincentown, including "yellow sand"
Hornerstown
Tinton
Red Bank
Navesink Mount Laurel
Wenonah
Marshalltown
Englishtown
Woodbury
Merchantville
Magothy (Including Cliffwood Clay)
Raritan

of the "Middle Marl," and the base of the "Upper Marl." Clark included this bed at first with the "Upper Marl" in his Manasquan formation. Later, however, he removed it entirely from the Cretaceous and considered it as of Miocene age.[1] The writer, after finding an abundance of Cretaceous fossils in the formation, referred this sand definitely to a position in the Cretaceous, it being the exact equivalent of the Vincentown limesand, and this interpretation has been assented to by Dr. Clark.

It is believed that the following Table IV is a representation of the stratigraphic divisions of the Cretaceous formations of New Jersey to which all who have studied the region will assent. The formations have not been grouped in any major divisions, for in New Jersey, at least, any major stratigraphic grouping is of doubtful utility. An arrangement of the formations will be discussed later, after a treatment of the faunas themselves.

[1] Geol. Surv. of N. J., Ann. Rep. State Geol. for 1892, p. 205; Ibid, for 1893, p. 338; Ibid. for 1897, p. 186 and p. 190; Bull. Geol. Soc. An., vol. viii, p. 336 and p. 340.

CHAPTER II.

THE RARITAN CLAY.[1]

The Raritan[2] formation is the lowest division of the Cretaceous in New Jersey. It consists of a number of beds of clay, sand, and locally gravel. The clays are of various sorts, from nearly white to steel-blue and black, some beds are often sandy and at times considerable quantities of pyrite and lignite are included. Some of the sands are nearly pure quartz, sharp and angular in grain, others are highly micaceous, or lignitic or arkose.

In the report on the Clays and Clay Industry of New Jersey[3] seven beds are described which may be included in the Raritan formation proper: these beds being (1) "Raritan Fire and Terra-cotta (Potter's) clay," (2) "Fire Sand No. 1," (3) "The Woodbridge Clay," (4) "The Feldspar-Kaolin Sand Bed," (5) "South Amboy Fire Clay," (6) "Sand Bed No. 3," (7) "Amboy Stoneware Clay. The total thickness of these beds is in the neighborhood of 200 feet. These subdivisions are, however, strictly local, and applicable only to the northeastern section in Middlesex and Monmouth counties.

Flora and Fauna of the Raritan Series. By far the most abundant fossil remains in the Raritan series are plants, and in a monograph upon the flora of the Amboy clays, Newberry[4] has described 156 species, most of which are from the Raritan forma-

[1] The descriptions of the physical characters of the formations have been compiled largely from the discussion of the formations by Kümmel and Knapp in Volume VI of the Final Reports of the State Geologist upon the Clays and Clay Industries of the State, and from the descriptions by Clark and Cook, supplementing the field observations of the writer.

[2] The term is here used in a restricted sense, indicated on page 22.

[3] Geol. Surv. N. J., Final Rep., vol. vi, pp. 168-196.

[4] The Flora of the Amboy Clays, by J. S. Newberry, a posthumous work edited by A. Hollick, Monog. U. S. G. S., vol. 26 (1895).

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tion proper, as that term is used here, although a few of the species described were secured from the higher beds here considered as representing the Magothy of Maryland. The flora is totally different from that of the Potomac clays further south in Maryland and Virginia from which beds Fontaine[1] has described 365 species, not one of which is certainly found in the Raritan clays of New Jersey[2].

"The difference in the character of the vegetation is shown by the fact that in the long list furnished by Professor Fontaine there are but 75 angiosperms (about one-fifth of all), whereas in the New Jersey clays, throwing out fragmentary and doubtful remains, of 156 described species all but 10 are dicotyledonous plants."

The fauna of the Raritan series is extremely meager. Conrad described a little pelecypod shell from the "ash-colored clays near Washington, Middlesex county," as *Astarte veta*,[3] this species must have come from the Raritan series, but it has not been met with in any of the more recent collections. In addition to this Whitfield has described four other species as follows:

Ambocardia cookii.
Corbicula ? emacerata.
Corbicula annosa.
Gnathodon ? tenuidens.

Three of these species, viz., *A. cookii, C. annosa* and *G. ? tenuidens,* occur in Sayre and Fisher's clay pits at Sayreville; two, viz., *A. cookii* and *G. ? tenuidens,* occur also at Valentine's clay pits near Woodbridge; two, viz., *C. ? emacerata* and *C. annosa,* are recorded from near Woodbridge with no definite locality specified; and one, viz., *A. cookii,* occurs also at East Brunswick. All of these localities are in the lower portion of the Raritan formation, and, although the generic relations of all the species are more or less in doubt, all seem to be of brackish-water types, just such forms as might be expected to occur in beds having the estuarine origin of these Raritan clays and sands.

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[1] The Potomac or Younger Mesozoic Flora, by W. M. Fontaine, Monog. U. S. G. S., vol. xv (1889).

[2] Newberry, loc. cit., p. 23.

[3] See fig. 3, pl. lx of the report.

More recently several examples of a small pelecypod, described in this report as *Corbula manleyi,* have been collected by Mr. J. M. Manley, of New Brunswick, from Furman's clay pits at Sayreville. Other members of the genus *Corbula* occur in the higher Cretaceous beds of the State, associated with typical marine faunas, but *C. manleyi* is quite different from any of these species. This same genus is living at the present time, some of the species having a typically marine habitat, while others live in brackish waters, and on account of this varying habitat of living members of the genus, the presence of this shell at Sayreville does not certainly indicate the presence of marine conditions, since this species may quite as well have been one of the brackish-water members of the genus.

Perhaps the most significant occurrence of invertebrate fossils in any of these Raritan beds is a concretionary slab of sandstone in the collection of the Geological Survey, collected from one of the clay banks at Sayreville by J. H. Congar in 1883. This slab is covered with many individuals of a species of *Turritella* (see plate LXXX of this volume), which is similar to and perhaps identical with a species occurring in the Cliffwood clay and described in this report as *T. jerseyensis.* Upon the same slab is an imperfect impression of a small pelecypod shell, which has the general form and proportions of *Cymbophora lintea,* a species particularly abundant in the Cliffwood clay, and also occurring in several of the higher Cretaceous formations in the State. Both of these forms are typically marine, and their occurrence here near the base of the Raritan series, and the reappearance of the same or of closely allied species in the Cliffwood clays, and again in the higher Cretaceous beds, affords evidence of the presence, at no great distance, of marine conditions, with faunas closely allied to those of the Matawan series, throughout the whole of Raritan time.

CHAPTER III.

THE MAGOTHY FORMATION.

Certain beds of clay and sand along the south shore of Raritan Bay have called forth considerable discussion of late years[1]. These beds were in large part, perhaps entirely, included by Cook in his "plastic clay" series, being included in his "clay and lignite" division at the summit of the series.[2] The name Cliffwood has been applied to these beds by Kümmel.[3] The beds are not always of clay, sometimes being largely arenaceous, as at Prospect Grove, where 40 feet of white sand, with seams of black lignite and thin beds of black clay (becoming thicker and more numerous towards the base of the section) occur immediately beneath the Merchantville clay-marl of the Matawan series.

From a study of the flora of these Cliffwood beds, Berry has

[1] The Cretaceous Clay Marl Exposures at Cliffwood, N. J., by Arthur Hollick, Trans. N. Y. Acad. Sci., vol. xvi., pp. 124-136; The Flora of the Matawan Formation (Crosswick's Clays), by Edward W. Berry, Bull. N. Y. Bot. Garden, vol. iii., No. 9, pp. 45-103; New Species of Plants from the Matawan Formation, by Edward W. Berry, Am. Nat., vol. xxxvii., pp. 677-684; The Cliffwood Clays and the Matawan, by G. N. Knapp, Amer. Geol., vol. xxxiii., pp. 23-27; The Cretaceous Exposure near Cliffwood, N. J., by Edward W. Berry, Amer. Geol., vol. xxxiv., pp. 253-260; The Matawan Formation of Maryland, Delaware and New Jersey, and Its Relations to Overlying and Underlying Formations, by W. B. Clark, Am. Jour. Sci., 4th Ser., vol. xviii., pp. 435-440; Additions to the Flora of the Matawan Formation, by Edward W. Berry, Bull. Torrey Bot. Club, vol. xxxi, pp. 67-82; Additions to the Fossil Flora From Cliffwood, New Jersey, by Edward W. Berry, Bull. Torrey Bot. Club, vol. xxxii, pp. 43-48; The Fauna of the Cliffwood Clays, by Stuart Weller, Jour. Geol., vol. 13, pp. 324-337; also Geol. Surv. N. J., Rep. of State Geol. for 1904, pp 133-144; The Flora of the Cliffwood Clays, by Edward W. Berry, Geol. Surv. N. J., Rep. of State Geol. for 1905, pp. 135-156.

[2] Geol. of N. J. (1868), p. 255; Geol. Surv. of N. J., Rep. on Clays (1878), p. 73.

[3] Geol. Surv. of N. J., Final Rep., vol. vi, Clays and Clay Industry of N. J. (1904), p. 166.

been led to correlate them and the underlying sand strata down to the top of the "Amboy Stoneware Clay" with the Magothy formation of Maryland. The lower contact of this Magothy formation as it is developed in New Jersey, is marked by a more or less conspicuous line of unconformity. The contact with the Merchantville clay, the formation next above, is sharp and easily recognized although the two formations are perfectly conformable. Wherever seen the top of the Magothy is a loose sand, or a sand with clay laminæ, whereas the Merchantville is a glauconitic clay, black when fresh, rusty-brown when weathered, and usually fossiliferous. This contact, moreover, is frequently emphasized by a bed of ironstone due to the cementation of the upper layer of the Magothy sand. Somewhat extended studies of the flora of the Cliffwood clays have been made by Berry[1]. In his most recent paper on the flora he has recorded a total of 49 species which are confined to the Magothy, although one or two are also known from Europe. In addition to this number there are several others, described by Newberry as from the Raritan of New Jersey, but which have not been detected in the comparatively abundant recent collections from the Raritan proper, having been found only in certain lower Magothy beds near Morgan, from which horizon they were probably obtained by Newberry. Of the Magothy species which are known from outside this formation, 36 occur in the Raritan of New Jersey, but if certain species having a wide geographic distribution and geologic range are removed from this number and some others which are not satisfactorily identified by reason of the imperfection of their preservation, it is found that about 25 per cent. of the flora is common to the Raritan of New Jersey. Thirty-one species in the flora, including several not found in the New Jersey Raritan, occur in the supposed Raritan beds of Staten Island, Long Island and eastward, but it is quite possible that the Magothy beds occur also on these islands, and that some of the supposed Raritan species belong rather to the higher flora. Twelve species in the flora are confined to the Magothy and Dakota floras, while on the other hand there are only 5 species peculiar

[1] See foot note, p. 31.

to the Magothy and the Raritan, even when including under the head of Raritan all the Island species, some of which may in reality be Magothy and not Raritan at all. The flora "contains a number of modern types not found in the Raritan, and has a general facies allying it to those floras elsewhere which are usually classed as Cenomanian such as that from the Dakota sandstone of the West or that from the Atane beds of Western Greenland. Comparing this flora with that of the world we note that it contains 42 species of the Albanian or Gault and 49 species of the Cenomanian or Senonian, and that while it marks the upper limit of 13 Albian or Gault species, it marks the lower limit of 17 Cenomanian or Senonian species."

The faunas of the Cliffwood clays have an especial interest from the fact that they represent the earliest abundant marine invertebrate fauna known in the Cretaceous of New Jersey. This fauna occurs at several localities which will be mentioned in order.

Locality 105. At Cliffwood Point this fauna occurs in smooth, concretionary nodules, for the most part not *in situ,* which may be gathered along the beach in great numbers at low tide. A few of the nodules were found imbedded in the clay near the water level. Probably all of them have been weathered out of a very few feet of strata, the nodule-bearing bed being some feet below the plant-bearing beds of the same locality. The most notable feature of these fossiliferous nodules is the great number of crustacean remains which they contain, indeed, nearly every one of the concretions, when broken, yields remains, more or less fragmentary and crushed, of one of these creatures, and a crab of some sort seems to have been the nucleus around which nearly every one of these concretionary nodules in the clay has been formed. Notwithstanding their abundance, no attempt has been made in the present report to give descriptions of the various forms, except in one single case of a species which also occurs commonly in the Woodbury clay. In addition to the crustaceans these nodules have yielded a goodly number of mollusca, and the following species have been recognized[1]:

[1] Additional investigation has led to some changes in identification and nomenclature from the preliminary lists previously published.

PELECYPODA.

Nucula percrassa Con.
Nucula whitfieldi n. sp.
Leda cliffwoodensis n. sp.
Yoldia cliffwoodensis n. sp.
Nemodon brevifrons Con.
Axinea congesta (Con.).
Inoceramus proximus Tuom.
Pteria petrosa Con.
Ostrea cretacea Mort.
Ostrea congesta Con.
Pecten cliffwoodensis n. sp.
Anomia argentaria Mort.
Mytilus oblivius Whitf.?
Pholadomya occidentalis Mort.
Lucina cretacea Whitf.
Tenea parilis Con.?
Cardium ripleyanum Con.
Isocardia cliffwoodensis Weller.
Tellina sp. undet.
Cymbophora lintea (Con.).
Schizodesma appressa Gabb.?
Corbula bisculata Con.

GASTROPODA.

Turritella quadrilirata Johns.
Pyrifusus erraticus Whitf.
Volutoderma conradi Gabb.

CEPHALOPODA.

Placenticeras placenta DeKay.
Baculites sp.

CRUSTACEA.

Tetracarcinus subquadratus Weller.

Locality 185.—A sandstone mass was collected on the beach at Cliffwood, 18 inches in length, 12 inches in width, and about

3 inches thick, which was filled with fossils. This mass of sandstone, collected along with the crustacean nodules, was not *in situ*, and being different in its lithologic characters from any material observed imbedded in the clay at this point, it may have been transported to this locality from elsewhere. It is somewhat similar in its lithologic characters to certain sandy, fossiliferous nodules occuring in the clay pits of the Cliffwood Brick Company, a little over 1.5 miles distant, on Whale Creek. The fauna yielded by this standstone undoubtedly indicates its Cliffwood age, although several species occur which have not been observed elsewhere. The species identified are the following:

PELECYPODA.

Leda cliffwoodensis n. sp.
Yoldia cliffwoodensis n. sp.
Trigonarca triquetra Con.
Trigonarca cliffwoodensis n. sp.
Axinea congesta Con.
Anatina sp. undet.
Cardium cliffwoodensis n. sp.
Isocardia cliffwoodensis Weller.
Cymbophora lintea (Con.).
Corbula cliffwoodensis n. sp.
Corbula jerseyensis n. sp.

GASTROPODA.

Gyrodes sp. undet.
Turritella jerseyensis n. sp.
Anchura pergracilis Johns.
Herchorhynchus jerseyensis n. sp.
Volutomorpha kanei (Gabb)?

Locality 186.—At Geldhaus' clay pits, a little over 1 mile west of Cliffwood Point, on Whale Creek, crustacean-bearing nodules similar to those collected on the beach at Cliffwood, occur *in situ* in the clay. Besides the numerous imperfect crustacean remains, the following species have been recognized at this locality:

PELECYPODA.

Leda cliffwoodensis n. sp.
Pteria petrosa Con.
Lucina cretacea Whitf.
Isocardia cliffwoodensis Weller.
Solyma lineolata Con.?
Cymbophora lintea (Con.).
Corbula sp. undet.

Locality 107.—In the Cliffwood Brick Company's south pits, at the crossing of the New York and Long Branch Railroad over Whale Creek, numerous, abundantly fossiliferous, sandy nodules were obtained *in situ* in the northern part of the pits, and from these nodules the following species of fossils have been identified:

PELECYPODA.

Leda cliffwoodensis n. sp.
Yoldia cliffwoodensis n. sp.
Axinea congesta (Con.).
Pecten cliffwoodensis n. sp.
Pholadomya occidentalis Mort.
Cymella bella Con.
Cardium cliffwoodensis n. sp.
Isocardia cliffwoodensis Weller.
Cyprimeria cretacea Con.
Meretrix tippana Con.
Tellina sp. undet.
Linearia metastriata Con.
Leptosolen biplicata Con.
Cymbophora lintea (Con.).
Schizodesma appressa Gabb.?
Corbula bisculata Con.

GASTROPODA.

Gyrodes sp. undet.
Turritella quadrilirata Johns.
Fusus cliffwoodensis n. sp.

Locality 189.—Several fossiliferous nodules, not *in situ*, were collected in the southern portion of the same pits of the Cliffwood Brick Company as the fauna last recorded. They undoubtedly had their origin from these same beds, having been thrown aside during the excavation of the clay for the purpose of brick-making. The following species of fossils have been recognized:

PELECYPODA.

Leda cliffwoodensis n. sp.
Nemodon sp. undet.
Axinea congesta (Con.).
Inoceramus proximus Tuom.
Pteria petrosa (Con.).
Ostrea sp. undet.
Pecten cliffwoodensis n. sp.
Anomia argentaria Mort.
Cardium ripleyanum Con.?
Isocardia cliffwoodensis Weller.
Cymbophora lintea (Con.).
Corbula bisulcata Con.
Corbula swedesboroensis n. sp.?

GASTROPODA.

Pyrifusus sp. undet.

CRUSTACEA.

Tetracarcinus subquadratus Weller.

TABLE OF DISTRIBUTION FOR THE CLIFFWOOD FAUNA.

In the following table the entire Cliffwood fauna is arranged to show the abundance of the individual species in the Cliffwood formation, as well as their occurrence and abundance in other formations. The numbers in parentheses following the names of the formations at the head of the successive columns indicate the number of localities from which collections have been secured

and studied. The numbers in the columns opposite the species name indicate in each case the number of localities from which the species has been recognized, and a comparison of this number with the number in parentheses at the head of the column shows the relative abundance of the species in the formations where it occurs. In the list, the species are arranged in groups in accordance with the number of occurrences which have been noted in the Cliffwood fauna; that is to say, the first three species have been recognized in each of the five localities from which Cliffwood fossils have been studied, and may, consequently, be considered as being among the most characteristic species of the fauna, and so on down to those species which have been noted from but a single locality.

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Leda cliffwoodensis n. sp.	5												
Isocardia cliffwoodensis n. sp.	5	—	1	—	—	1	—	—	—	—	—	—	X
Cymbophora lintea (Con.)	5	3	4	—	1	2	—	3	1	—	—	—	X
Axinea congesta (Con.)	4	—	2	—	—	1	—	—	—	—	—	—	X
Yoldia cliffwoodensis n. sp.	3												
Pteria petrosa Con.	3	—	—	—	—	2	—	—	—	—	—	—	X
Pecten cliffwoodensis n. sp.	3												
Corbula bisulcata Con.	3	3	1	—	—	—	—	—	—	—	—	—	X
Inoceramus proximus Tuom.	2	5	—	—	1	—	—	—	—	—	—	—	X
Anomia argentaria Mort.	2	6	3	—	2	1	3	1	—	—	—	—	X
Pholadomya occidentalis Mort.	2	4	2	—	—	—	—	—	—	—	—	—	X
Lucina cretacea Whitf.	2	—	6	—	—	—	—	2	—	—	—	—	X
Cardium ripleyanum Con.	2	4	6										
Cardium cliffwoodensis n. sp.	2												
Schizodesma appressa Gabb.?	2	—	—	—	—	2	—	—	—	—	—	—	X
Turritella quadrilirata Johns.	2	—	1										
Tetracarcinus subquadratus Weller	2	—	1										
Nucula percrassa Con.	1	3	2	—	1	1	—	—	—	—	—	—	X
Nucula whitfieldi n. sp.	1	3	4	—	—	2	—	2	—	—	—	—	
Nemodon brevifrons Con.	1	—	—	—	—	2	—	—	—	—	—	—	X
Trigonarca triquetra Con.	1	—	—	—	—	—	—	—	—	—	—	—	X
Trigonarca cliffwoodensis n. sp.	1												
Ostrea cretacea Mort.	1	—	—	—	—	—	—	—	—	—	—	—	X
Ostrea congesta Con.	1	—	—	—	—	—	—	—	—	—	—	—	X
Mytilus oblivius Whitf.?	1	—	—	—	—	1							
Cymella bella Con.	1	1	3	—	—	1	—	—	—	—	—	—	X
Tenea parilis Con.?	1	2	5	—	—	2	2	2	1	—	—	—	X
Cyprimeria cretacea Con.	1	—	5	—	—	1							
Meretrix tippana Con.	1	3	—	—	—	1	—	—	—	—	—	—	X
Linearia metastriata Con.	1	3	2	—	1	1	—	1	—	—	—	—	X
Leptosolen biplicata Con.	1	3	1	—	—	2	3	3	—	—	—	—	X
Solyma lineolata Con.?	1	3	3	—	—	1	—	1	—	—	—	—	X
Corbula cliffwoodensis n. sp.	1												
Corbula jerseyensis n. sp.	1												
Corbula swedesboroensis n. sp.?	1	1	1	—	1								
Turritella jerseyensis n. sp.	1												
Anchura pergracilis Johns.	1	—	1										
Pyrifusus erraticus Whitf.	1												
Herchorhynchus jerseyensis n. sp.	1												
Fusus cliffwoodensis n. sp.	1												
Volutoderma conradi Gabb.	1	—	—	—	—	—	1						
Piestochilus kanei Gabb.	1	—	—	—	—	1							
Placenticeras placenta (DeKay)	1	4	2	—	1	2	—	—	—	—	—	—	X

ANALYTICAL DISCUSSION OF THE CLIFFWOOD FAUNA.

The composition of the entire fauna of the Cliffwood clays, as exhibited in the five localities recognized, is shown in the above table, with the distribution of the recognized species in the other Cretaceous formations of New Jersey and a record of their occurrence in the Ripley Group of the Southern States. The essential features of this table, in so far as the number of species in the various formations is concerned, may be shown as follow:

CLIFFWOOD,	43
Merchantville,	16
Woodbury,	21
Marshalltown,	7
Wenonah,	19
Mt. Laurel-Navesink,	4
Red Bank,	8
Tinton,	2
Ripley Group, etc.,	22

Of the total 43 species recognized in the Cliffwood fauna 14, or 32 per cent., have not been recognized in any other formation in New Jersey, so that only 29 species have a wider range within the State. Of the 22 species which are known to occur also in the Cretaceous beds outside of New Jersey, chiefly in the Ripley formations of the Southern States, all but three are also included in the 29 species which have a wider distribution in the State, the exceptions being *Ostrea cretacea*, *Ostrea congesta* and *Trigonarca triquetra*.

In passing from the Cliffwood to the Tinton in this table a reduction in the number of species in common to the formations is noticeable, as might be expected, the reduction being from the total number of species in the Cliffwood to only two in the Tinton. A highly important fact, however, in the data exhibited by this table is that the reduction in the number of common species in the successive formations is not regular, there being a distinct alternation, the greater number of common forms being present in the Woodbury, Wenonah and Red Bank. This distinct alternation is not accidental, nor is it due to the fact that the entire known faunas of these formations are larger, for they are not. On the

contrary, the total number of known species in the Merchantville is greater than the entire known Woodbury fauna, and the total fauna of the Mount Laurel-Navesink horizon is larger than that of any other single formation in the series, being very much larger than the fauna of either the Wenonah or the Red Bank, although the faunas of each of these formations have much more in common with the Cliffwood than does the Navesink fauna. As will be shown later, there were two sharply marked alternating faunas in the beds from the Cliffwood to the Tinton inclusive.

A notable proportion of the Cliffwood species having a wider range within the State, viz., 11 species of the total 26, distinctly show the alternations in their occurrence, as follows:

	C	M	W	Ma	We	N	RB
Nemodon brevifrons	×	—	—	—	×		
Axinea congesta	×	—	×	—	×		
Pteria petrosa	×	—	—	—	×		
Mytilus oblivius	×	—	—	—	×		
Lucinia cretacea	×	—	×	—	—	—	×
Isocardia cliffwoodensis	×	—	×	—	×		
Cyprimeria cretacea	×	—	×	—	×		
Schizodesma appressa	×	—	—	—	×		
Turritella quadrilirata	×	—	×				
Anchura pergracilis	×	—	×				
Tetracarcinus subquadratus	×	—	×				

To the above list might be added *Nucula whitfieldi, Cymella bella* and *Cymbophora lintea,* species which are much more conspicuous in these alternate faunas, but which occur rarely in the intermediate stages. It is, indeed, not improbable that at least a portion of the species of the above list which are now known exclusively in these alternating faunas, may be found to occur rarely, with further collecting, in the intermediate beds, but the fact remains, and probably will not be altered with the most complete collections, that there is a distinct faunal element which is dominant in the Cliffwood, Woodbury, Wenonah and Red Bank faunas and which is inconspicuous in the Merchantville, Marshalltown, Navesink and Tinton, while, on the other hand, as will be shown below, a dominant element is present in the latter divisions which is not conspicuous in the former.

It is not possible to characterize fully the Cliffwood-Woodbury-Wenonah-Red Bank fauna by a single species, since no form has been so far recognized in every locality of every horizon of this fauna. *Lucina cretacea,* perhaps, more nearly characterizes the fauna than any other single species; it occurs in every locality of the Woodbury which has been studied, and is always a common species, but in the other horizons it has been found at only two of the five Cliffwood localities, two of the four Red Bank localities, and as yet has been found in neither of the Wenonah localities. It is really a group of species, rather than a single one which characterizes this fauna, but as a matter of convenience, the whole assemblage may be spoken of as the *Lucina cretacea fauna.* In the alternate formations of the series, viz., Merchantville, Marshalltown, Mount Laurel-Navesink and Tinton, *Lucina cretacea* does not occur, this species and its associates being replaced by another general fauna to be discussed later, in which the species of the genus *Cucullaea* take a conspicuous part.

Aside from this most characteristic element in the Cliffwood fauna, a second group of species, viz., *Pholadomya occidentalis, Cardium ripleyanum* and *Corbula bisulcata,* occur, which seem to be common to both of the two general faunas, but which are restricted to the lower portion of the entire series of formations, not being recognized at any horizon higher than the Woodbury. *Placenticeras placenta* is a species which is highly characteristic of all the formations beneath the Mount Laurel sand, and *Anomia argentaria, Tenea parilis, Leptosolen biplicata,* and *Linearia metastriata* are species which are commonly distributed through both of the general faunas. The more diagnostic species of the fauna which occurs in the Merchantville-Marshalltown-Navesink-Tinton formations, viz., *Axinea subaustralis* and members of the genus *Cucullaea,* are conspicuous for their entire absence from the Cliffwood fauna, although the presence of *Inoceramus proximus* is, perhaps, a sporadic occurrence of a genus which is more characteristic of the second group of faunas.

CHAPTER IV.

THE MERCHANTVILLE CLAY-MARL.

The Merchantville clay-marl is a black, glauconitic, micaceous clay, often somewhat sandy, the basal and upper portions of the bed commonly being more glauconitic than the middle portion. This three-fold division of the bed is usually noticeable wherever a complete section of the formation can be seen. At several localities the glauconitic portion of the formation is so highly charged with greensand that the bed has been dug for marl.

The weathering of the Merchantville clay-marl is usually very characteristic. The marly beds frequently form a more or less indurated, cinnamon-brown earth in which the small black grains of glauconite may be distinctly seen. When more sandy the weathered portion has a peculiar "pepper and salt" aspect. In the region about Jamesburg the weathered portion frequently contains yellow, ferruginous, sandy nodules. In areas where good sections of the formation cannot be seen, the bed can usually be recognized where it is not too deeply covered with Pleistocene deposits, by the rusty, cinnamon-brown color of the weathered basal and upper portions of the formation.

The contact of the Merchantville formation with the underlying beds is usually sharply defined, the upper portion of the subjacent formation usually being a loose, coarse, lignitic sand, often with thin seams of black clay. Frequently an indurated layer of ferruginous sandstone several inches in thickness marks the exact boundary between the formations. In the northeastern portion of the Cretaceous area of New Jersey, however, there are locally heavy beds of black clay, the Cliffwood clays, near the summit of the Magothy, which were at one time included by Clark in his Matawan formation[1]. Later, however, the same

[1] Geol. Surv. N. J., Ann. Rep. State Geol. for 1897, p. 175, and accompanying maps.

author has considered these clays as a distinct formation equivalent to the Magothy formation in Maryland[1]. These Cliffwood clays, with their associated sand and lignite, are clearly distinct from the Merchantville as has already been pointed out, both faunally and lithologically, and there is no great difficulty in tracing the basal line of the Merchantville even where the subjacent Magothy beds are argillaceous.

The transition from the Merchantville to the Woodbury above is less sharp than that between this formation and the subjacent one, but it is usually accomplished within a thickness of from one to three feet.

The thickness of the Merchantville clay-marl increases somewhat from northeast to southwest. In Monmouth County its thickness is about 35 feet, at Bordentown it is 60 feet, and in Salem County about the same.

FAUNAS OF THE MERCHANTVILLE CLAY-MARL.

The Merchantville clay-marl is usually fossiliferous where it is well exposed, especially the more glauconitic beds of the formation. More or less complete collections have been made from the formation at eight different localities along the belt of outcrop from Monmouth County near Raritan Bay to Merchantville in Camden County, a distance of about 60 miles. Through this entire extent the fauna retains its integrity in its more essential characteristics, and judging from collections in the Philadelphia Academy of Science the integrity of the fauna persists at least as far as the deep cut on the Delaware and Chesapeake canal in the State of Delaware, a further distance of 45 miles. In New Jersey, so far as it has been observed, the fauna is purer in the more northeastern localities from which it has been studied, the mingling of the species more characteristic of the Woodbury clay fauna being more noticeable to the southwest.

The eight local faunas of the formation which have been studied will be recorded in order, beginning with the more northeastern ones.

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[1] Am. Jour. Sci., 4th Ser., vol. 18, p. 440.

Locality 101[2].—In the northern portion of the Cretaceous area of the State, the most extensive Merchantville fauna has been collected from an exposure in a small ravine, tributary to Cheesequake Creek. The head of this ravine is just north of the road from Morristown to Jacksonville, about .75 of a mile west of Morristown and a little over 2 miles northwest of Matawan; it is the most westerly and largest of three similar ravines along the road west from Morristown, and the fossils were collected just below the road. At this locality two distinct beds are exposed, there being a dark clay below (101[1]), nearly or quite free from glauconite, and a chocolate-brown, highly glauconitic clay-marl bed above (101[2]). The fauna listed below was collected entirely from the higher bed.

ANTHOZOA.

Micrabacia americana M. & H.

ECHINODERMATA.

Catopygus pusillus Clark.

PELECYPODA.

Nucula whitfieldi n. sp.
Cucullaea antrosa Mort.
Breviarca cuneata Gabb.
Nemoarca cretacea Con.
Axinea subaustralis d'Orb.
Inoceramus proximus Tuom.
Ostrea tecticosta Gabb.?
Trigonia eufaulensis Gabb.
Pecten burlingtonensis Gabb.
Pecten argillensis Con.
Pecten conradi Whitf.
Neithea quinquecostata (Sow.)
Lima reticulata L. & F.
Anomia argentaria Mort.
Modiola monmouthensis n. sp.
Pholadomya occidentalis Mort.

Liopistha alternata n. sp.
Cymella bella Con.
Etea trapezoidea (Con).
Crassatellites cuneatus Gabb.
Crassatellites prora Con.
Cardium spillmani Con.
Cardium tenuistriatum (Whitf.).
Meretrix tippana Con.
Legumen planulatum (Con.).
Linearia metastriata Con.
Leptosolen biplicata Con.
Solyma lineolata Con.
Cymbophora lintea (Con.).
Corbula bisculcata Con.
Corbula crassiplica Gabb.
Corbula swedesboroensis n. sp.
Panopea decisa Con.
Pholas cithara Mort.
Teredo irregularis Gabb.

SCAPHOPODA.

Dentalium subarcuatum Con.

GASTROPODA.

Amauropsis meekana Whitf.
Gyrodes crenata Con.
Gyrodes altispira (Gabb.).
Endoptygma umbilicata (Tuom.).
Turritella merchantvillensis n. sp.
Laxispira lumbricalis Gabb.
Anchura rostrata (Gabb).
Pyropsis richardsoni Tuom.
Cancellaria subalta Con.
Cancellaria smocki n. sp.

CEPHALOPODA.

Placenticeras placenta (DeKay).
Scaphites hippocrepis (DeKay).

Several other localities in the northern portion of the Cretaceous area have yielded small collections of Merchantville fossils, but in no case has so extensive a fauna been secured as at locality 101[2], just described.

Locality 102[1]. The National Fireproofing Company has made extensive excavations in the Woodbury clay at Lorillard, east of Keyport, the clay used in the works being removed down to the top of the underlying Merchantville formation. The contact between the two formations is recognized at once in the excavation at this point, the lower formation being abundantly glauconitic, while the higher formation is quite free from greensand. In connection with the excavation at this locality, the work being done with a steam shovel, it is at times necessary to dig a shallow pit in the subjacent Merchantville formation, in order to furnish suction for the pumps, and at such times fossils from this lower formation can be secured. During the period of the writers visits to these pits, only a single opportunity was afforded to secure collections from this underlying bed (102[1]), and only the following meager fauna was obtained:

PELECYPODA.

Cucullaea antrosa Mort.
Nemoarca cretacea Con.
Cardium sp.

GASTROPODA.

Turritella sp.

VERTEBRATA.

Fish vertebra.

Extensive exposures of the Merchantville clay-marl may be seen along the west bank of Matawan Creek, north of the town of Matawan, the works of the Pennsylvania Clay Company being located at this point. The pits which furnish the raw material for the plant of this company, as well as other pits situated a little further north and no longer operated, afford an excellent section of the Merchantville formation resting upon the subjacent Ma-

gothy. The lowest bed exposed in this section (100[1]), is five feet of gray or variegated sand containing thin bands of lignite. Locally the uppermost six inches of this sand is indurated and forms a hard band of ferruginous sandstone. This sand is the uppermost portion of the Magothy, and its total unexposed thickness at this locality is not known.

Locality 100[2]. This bed represents the basal member of the Merchantville clay in the locality under consideration, and no extensive fauna has been found in it. It consists of two feet of dark glauconitic clay with numerous, irregular, ferruginous concretions. In the pits not operated at the present time, north of the Pennsylvania Clay Company's plant, an abundance of shark's teeth of several species occur weathered out upon the slope just below this portion of the section, along with an occasional fragment of a reptile bone. In the sides of a trench dug in this bed at the pits now being operated, an undetermined species of *Corbula* was collected, along with several shark's teeth of the same forms as those found loose, and a fish vertebra.

Locality 100[3]. This bed, 25 feet in thickness, is a black clay free from glauconite, but with some arenaceous bands, being dug at the present time in the Pennsylvania Clay Company's pits for use in the manufacture of bricks. Fossils are exceedingly rare, only a single specimen of *Inoceramus proximus* Tuom. being observed.

Locality 100[4]. Overlying the bed of black clay is a much weathered glauconitic bed of a brownish or yellowish color. Fossils are not uncommon in this bed, but they are poorly preserved because of their weathered condition. The species which have been identified are as follows:

PELECYPODA.

Cucullaea antrosa Mort.
Axinea subaustralis d'Orb.
Liopistha alternata n. sp.
Etea trapezoidea (Con.).
Cardium spillmani Con.
Cardium tenuistriatum (Whitf.).
Protocardia jerseyensis n. sp.
Panopea decisa Con.

GASTROPODA.

Gyrodes crenata Con.
Turritella merchantvillensis n. sp.

CEPHALOPODA.

Placenticeras placenta (DeKay).

Locality 140. Near Jamesburg the Merchantville clay-marl is exposed at several points and is abundantly fossiliferous. The most northeastern locality in this region, from which collections of fossils have been made, is situated about 3.5 miles a little north of east from the town of Jamesburg, at a road corner .5 miles west of Texas on Matchaponix Brook. This is an isolated outcrop by the roadside, which, in its present weathered condition, is a yellow, ferruginous, sandy bed. The species which have been identified from this locality are as follows:

VERMES.

Hamulus sp.

PELECYPODA.

Nucula whitfieldi n. sp.
Leda compressifrons (Whitf.).
Perrisonota protexta Con.
Yoldia sp.
Nemodon eufaulensis (Gabb).
Axinea subaustralis d'Orb.
Pinna laqueata Con.
Anomia argentaria Mort.
Anatina jamesburgensis n. sp.?
Liopistha alternata n. sp.
Veniella conradi Mort.
Etea trapezoidea (Con.).
Eriphyla conradi (Whitf.)
Cardium tenuistriatum (Whitf.).
Cardium ripleyanum Con.
Protocardia jerseyensis n. sp.
Meretrix sp.

Linearia metastriata Con.
Tellinimera eborea Con.
Corbula crassiplica Gabb.
Panopea decisa Con.
Gastrochaena linguiformis n. sp.

GASTROPODA.

Gyrodes sp.
Turritella merchantvillensis n. sp.
Anchura solitaria Whitf.
Volutoderma sp.

Locality 139. This locality lies 3 miles due east of Jamesburg. It is a small outcrop at the side of the road running south from Spotswood, and is about 2.5 miles south of that place. The fossils collected are as follows:

ECHINODERMATA.

Hemiaster welleri Clark n. sp.

PELECYPODA.

Leda compressifrons (Whitf.).
Leda sp.
Nemodon eufaulensis (Gabb.).
Cucullaea sp.
Axinea subaustralis d'Orb.
Inoceramus proximus Tuom.
Ostrea sp.
Pecten conradi Whitf.
Pecten argillensis Con.
Anomia argentaria Mort.
Anomia radiata n. sp.?
Pholadomya occidentalis Mort.
Anatina jamesburgensis n. sp.
Liopistha alternata n. sp.
Liopistha kümmeli n. sp.
Veniella conradi Mort.
Eriphyla conradi Whitf.

Cardium tenuistriatum Whitf.
Cardium ripleyanum Con.
Tellinimera eborea Con.
Leptosolen ? terminalis n. sp.
Solyma lineolata Con.
Cymbophora lintea (Con.).
Corbula crassiplica Gabb.

GASTROPODA.

Gyrodes petrosa Mort.
Turritella merchantvillensis n. sp.
Anchura solitaria Whitf.

CEPHALOPODA.

Scaphites hippocrepis (DeKay).

Locality 141.—This locality is in the first railway cut, 1 mile southeast of the Lower Jamesburg station. The beds exposed here are the typical glauconitic clays of the Merchantville, and are much less weathered than those at the last two localities. The fossils are abundant, and occur for the most part in concretionary, ferruginous nodules. The species which have been identified are the following:

ECHINODERMATA.

Hemiaster welleri Clark n. sp.

VERMES.

Hamulus? sp.

PELECYPODA.

Nucula percrassa Con.
Leda compressifrons (Whitf.).
Perrisonota protexta Con.
Nemodon eufaulensis (Gabb).
Trigonarca cuneiformis Con.
Breviarca cuneata (Gabb).
Nemoarca cretacea Con.

Axinea subaustralis d'Orb.
Inoceramus proximus Tuom.
Pecten burlingtonensis Gabb.
Pecten conradi (Whitf.).
Anomia argentaria Mort.
Modiola julia Lea.
Pholadomya occidentalis Mort.
Anatina jerseyensis n. sp.
Veniella conradi Mort.
Eriphyla conradi (Whitf.)
Crassatellites cuneatus Gabb.
Tenea parilis Con.
Cardium tenuistriatum (Whitf.)
Cardium ripleyanum Con.
Meretrix tippana Con.
Legumen planulatum (Con.).
Tellinimera eborea Con.
Leptosolen biplicata Con.
Cymbophora lintea (Con.).
Corbula bisulcata Con.
Corbula crassiplica Gabb.

SCAPHOPODA.

Dentalium subarcuatum Con.

GASTROPODA.

Gyrodes crenata Con.
Turritella merchantvillensis n. sp.
Laxispira lumbricalis Gabb.
Anchura solitaria Whitf.

CEPHALOPODA.

Placenticeras placenta (DeKay).

Locality 163.—The next locality which has afforded an abundant fauna from the Merchantville formation is A. Reeve's clay pit, on the north branch of Pensauken Creek, at Lenola, 2 miles west of Moorestown. This locality lies about 40 miles

southwest, along the strike of the Cretaceous beds, from Jamesburg, much of the intervening region being too heavily drift-covered to permit the examination of the underlying Cretaceous beds. From the shores of Raritan Bay, the locality is distant over 50 miles. This locality has been frequently visited by collectors from the Philadelphia Academy of Science, and many fossils from here are preserved in the collections of that institution. In the following list an attempt has been made to make the list of the Lenola fauna as complete as possible, and a few species have been included which have been seen by the writer only in the collections of the Philadelphia Academy. All such species are designated by an asterisk (*).

ECHINODERMATA.

Hemiaster welleri Clark n sp.

VERMES.

Hamulus lineatus n. sp.

PELECYPODA.

Nucula percrassa Con.
Nucula whitfieldi n. sp.
Perrisonota protexta Con.
Nemodon eufaulensis (Gabb.).
Cucullaea antrosa Mort.
Cucullaea neglecta Gabb.
Arca obesa (Whitf.).
Nemoarca cretacea Con.
Axinea subaustralis d'Orb.
Pinna laqueata Con.
Gervilliopsis ensiformis Con.
Inoceramus proximus Tuom.
Ostrea sp.
Exogyra sp.
Trigonia eufaulensis Gabb.
Pecten burlingtonensis Gabb.
Pecten conradi Whitf.
Pecten argillensis Con.

Neithea quinquecostata (Sow.).
Lima reticulata (L. & F.).
Anomia argentaria Mort.
**Anomia radiata* n. sp.
Paranomia scabra Mort.
Pholadomya occidentalis Mort.
Corimya ? sp.
Liopistha kümmeli n. sp.
Veniella conradi Mort.
Etea trapezoidea (Con.).
Eriphyla conradi (Whitf.).
Crassatellites cuneatus Gabb.
Vetericardia crenilirata Con.
Tenea parilis Con.
Cardium tenuistriatum (Whitf.).
Cardium ripleyanum Con.
Cardium pilsbryi n. sp.
Cyprimeria densata (Con.).
Meretrix tippana Con.
Legumen planulatum (Con.).
Linearia metastriata Con.
Leptosolen biplicata Con.
Solyma lineolata Con.
Corbula bisulcata Con.
Corbula crassiplica Gabb.
Panopea decisa Con.
Turnus kümmeli n. sp.
Martesia cretacea Gabb.
Teredo irregularis Gabb.

SCAPHOPODA.

Dentalium subarcuatum Con.

GASTROPODA.

Margarita abyssima Gabb.
**Scala sillmani* Mort.
Lunatia halli Gabb.

Gyrodes crenata Con.
Gyrodes altispira (Gabb).
Gyrodes petrosa Mort.
Endoptygma umbilicata (Tuom.).
Turritella merchantvillensis n. sp.
Turritella lenolensis n. sp.
Laxispira lumbricalis Gabb.
Cerithium pilsbryi Whitf.
Anchura rostrata (Gabb).
Pyropsis lenolensis n. sp.
Pyropsis sp.
Odontofusus slacki (Gabb).
Turbinella intermedia n. sp.
**Volutomorpha conradi* Gabb?
Volutoderma biplicata (Gabb).
Volutoderma woolmani Whitf.
Rostellites texturatus Whitf.
**Rostellites nasutus* Gabb.
**Modulus lapidosus* Whitf.
Morea naticella Gabb.
Avellana bullata Mort.

CEPHALOPODA.

Placenticeras placenta (DeKay).
Mortonoceras delawarensis (Mort.).
Scaphites hippocrepis (DeKay).
Baculites ovatus Say.

CRUSTACEA.

Hoploparia gabbi Pils.
Hoploparia gladiator Pils.
Callianassa mortoni Pils.
Cancer ? whitfieldi Pils.

VERTEBRATA.

Shark's teeth.

Locality 162.—In the railroad cut just east of the village of Merchantville, over which the wagon road to Moorestown is carried by a bridge, the Merchantville beds are well exposed. These beds are largely the typical chocolate-brown, glauconitic clays of the formation, but the fauna is much inferior, both in the number of species and in the perfection of preservation, to that at Lenola. The following species have been recognized:

PELECYPODA.

Nucula percrassa Con.
Axinea subaustralis d'Orb.
Inoceramus proximus Tuom.
Pecten conradi Whitf.
Anomia argentaria Mort.
Paranomia ? sp.
Veniella conradi Mort.
Etea trapezoidea (Con.).
Eriphyla conradi (Whitf.).
Cardium tenuistriatum (Whitf.).
Cyprimeria sp.
Corbula sp.

SCAPHOPODA.

Dentalium subarcuatum Con.

GASTROPODA.

Turritella merchantvillensis n. sp.
Cerithium pilsbryi Whitf.
Anchura rostrata (Gabb).
Odontofusus slacki (Gabb).
Avellana bullata Mort.

CRUSTACEA.

Callianassa sp.

VERTEBRATA.

Shark's teeth.

TABLE OF DISTRIBUTION FOR THE MERCHANTVILLE FAUNA[1].

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Axinea subaustralis d'Orb.	—	7	—	—	—	—	7	—	5	—	—	—	×
Cardium tenuistriatum (Whitf.)	—	7	—	—	3	1	11						
Turritella merchantvillensis n. sp.	—	7											
Anomia argentaria Mort.	2	6	3	—	2	1	3	1	—	—	—	—	×
Inoceramus proximus Tuom.	2	5	—	—	1	—	—	—	—	—	—	—	×
Pecten conradi Whitf.	—	5	6	—	—	—	2						
Veniella conradi Mort.	—	5	2	—	1	2	4	3	1	—	—	—	××
Etea trapezoidea (Con.)	—	5	—	—	—	—	—	—	—	—	—	—	×
Eryphyla conradi Whitf.	—	5	2										
Corbula crassiplica Gabb.	—	5	5	—	—	2	1	2	—	—	—	—	×
Nemodon eufaulensis (Gabb.)	—	4	—	—	1	—	2	3	1	—	—	—	××
Cucullaea antrosa Mort.	—	4	—	—	—	—	10	—	1	—	—	—	××
Nemoarca cretacea Con.	—	4	5	—	—	1	—	1					×
Pholadomya occidentalis Mort.	2	4	2	—	—	—	—	—	—	—	—	—	×
Liopistha alternata n. sp.	—	4											
Cardium ripleyanum Con.	2	4	6										
Panopea decisa Con.		4	2	—	—	1	3	1	—	—	—	—	××
Dentalium subarcuatum Con.	—	4	4	—	—	—	—	—	—	—	—	—	××
Gyrodes crenata Con.	—	4	1	—	—	1	—	—	—	—	—	—	×
Placenticeras placenta (DeKay)	1	4	2	—	1	2	—	—	—	—	—	—	××
Hemiaster welleri Clark n. sp.	—	3											
Nucula percrassa Con.	1	3	2	—	1	1	—	—	—	—	—	—	×
Nucula whitfieldi n. sp.	1	3	4	—	—	2	—	2					
Leda compressifrons (Whitf.)	—	3	4										
Perrisonota protexta Con.	—	3	2	—	—	1	—	3	1				
Pecten burlingtonensis Gabb.	—	3	2	—	—	1							
Pecten argillensis Con.	—	3	2	—	1	1	2	—	—	—	—	—	×
Crassatellites cuneatus Gabb.	—	3	—	—	—	1							
Meretrix tippana Con.	1	3	—	—	—	1	—	—	—	—	—	—	××
Legumen planulatum (Con.)	—	3	3	—	—	1	3	1	—	—	—	—	××
Linearia metastriata Con.	1	3	2	—	1	1		1	—	—	—	—	××
Tellinimera eborea Con.		3	1	—	—	2	—	1	—	—	—	—	××
Leptosolen biplicata Con.	1	3	1	—	—	2	3	3	—	—	—	—	××
Solyma lineolata Con.	1	3	3	—	—	1		1	—	—	—	—	××
Cymbophora lintea (Con.)	5	3	4	—	1	2	—	3	1	—	—	—	×

[1] The plan of arrangement of this table is the same as that for the Cliffwood fauna on page 39.

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Corbula bisulcata Con.	3	3	1	—	—	—	—	—	—	—	—	—	—
Laxispira lumbricalis Gabb.	—	3	2	—	—	—	—	—	—	—	—	—	X
Anchura rostrata Gabb.	—	3	4	—	—	1	—	—	—	—	—	—	X
Anchura solitaria Whitf.	—	3											
Breviarca cuneata Gabb.	—	2	1	—	—	—	—	—	—	—	—	—	—
Pinna laqueata Con.	—	2	1	—	—	—	3	—	—	—	—	—	X
Trigonia eufaulensis Gabb.	—	2	2	—	—	2	—	—	—	—	—	—	X
Neithea quinquecostata (Sow.)	—	2	—	—	3	—	3	—	—	—	—	—	—
Lima reticulata (L. & F.)	—	2	—	—	1	1	8	2	1	—	—	—	—
Anomia radiata n. sp.	—	2	1										
Anatina jamesburgensis n. sp.	—	2											
Liopistha kümmeli n. sp.	—	2											
Tenea parilis Con.	1	2	5	—	—	2	2	2	1	—	—	—	X
Cardium spillmani Con.	—	2	—	—	—	—	7	—	—	—	—	—	X
Protocardia jerseyensis n. sp.	—	2											
Teredo irregularis Gabb.	—	2	—	—	—	—	—	—	—	—	—	—	X
Gyrodes altispira (Gabb)	—	2											
Gyrodes petrosa Mort.	—	2	—	—	—	2	10	2	—	—	—	—	X
Endoptygma umbilicata (Tuom.)	—	2	—	—	—	—		—	—	—	—	—	X
Cerithium pilsbryi Whitf.	—	2											
Odontofusus slacki (Gabb)	—	2											
Avellana bullata Mort.	—	2											
Scaphites hippocrepis (DeKay)	—	2											
Micrabacia americana M. & H.	—	1	3	—	—	1							
Catopygus pusillus Clark	—	1											
Cucullaea neglecta Gabb.	—	1	—	—	—	—	8	—	—	—	—	—	X
Trigonarca cuneiformis Con.	—	1	2										
Arca obesa (Whitf.)	—	1											
Gervilliopsis ensiformis Con.	—	1	1	—	—	1	3	1	—	—	—	—	X
Ostrea tecticosta Gabb.?	—	1	2	—	—	1							
Paranomia scabra Mort.	—	1	—	—	2	—	4	—	—	—	—	—	X
Modiola julia Lea	—	1	4	—	—	—		—	—	—	—	—	X
Modiola monmouthensis n. sp.	—	1											
Anatina jerseyensis n. sp.	—	1	1	—	—	1							
Cymella bella Con.	1	1	3	—	—	1	—	—	—	—	—	—	X
Vetericardia crenilirata Con.	—	1	2	—	—	—	—	—	—	—	—	—	X
Cardium pilsbryi n. sp.	—	1											
Cyprimeria densata (Con.)	—	1											
Leptosolen ? terminalis n. sp.	—	1											
Corbula swedesboroensis n. sp.	1	1	1	—	1								
Gastrochaena linguiformis n. sp.	—	1											
Pholas cithara Mort.	—	1	2	—	—	1	—	—	—	—	—	—	X
Turnus kümmeli n. sp.	—	1	—	—	1								
Martesia cretacea Gabb.	—	1	—	—	1								

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Margarita abyssima Gabb	—	1	1	—	—	—	9	—	1				
Scala sillmani Mort	—	1	—	—	1	2	1	1	1				
Lunatia halli Gabb	—	1	—	—	—	2	14	—	—	—	—	—	×
Amauropsis meekana Whitf	—	1	4										
Turritella lenolensis n. sp	—	1	1										
Pyropsis richardsoni (Tuom.)	—	1	—	—	—	—	1	—	—	—	—	—	×
Pyropsis lenolensis n. sp	—	1											
Turbinella intermedia n. sp	—	1											
Volutomorpha conradi Gabb.?	—	1	—	—	—	—	—	—	—	—	—	—	×
Volutoderma biplicata (Gabb)	—	1	1	—	1	1							
Volutoderma woolmani Whitf	—	1											
Rostellites texturatus Whitf	—	1											
Rostellites nasutus Gabb	—	1	—	—	—	—	5						
Modulus lapidosus Whitf	—	1											
Cancellaria subalta Con	—	1	5										
Cancellaria smocki n. sp	—	1	2										
Morea naticella Gabb	—	1											
Mortonoceras delawarensis (Mort.)	—	1											
Baculites ovatus Say	—	1	2	—	—	—	6	—	—	—	—	—	×
Hoploparia gabbi Pilsb	—	1											
Hoploparia gladiator Pilsb	—	1											
Callianassa mortoni Pilsb	—	1	—	—	—	—	4	—	4				
Cancer ? whitfieldi Pilsb	—	1											

ANALYTICAL DISCUSSION OF THE MERCHANTVILLE FAUNA.

The data recorded in the preceding table may be summarized as follows, to show the number of species common to the Merchantville and to each of the other formations in the series. Thirty-three of the species or 32 per cent. which have been recognized in the Merchantville have not been seen in any other horizon, which leaves 69 species having a greater range.

Cliffwood,	16
MERCHANTVILLE,	102
Woodbury,	48
Marshalltown,	18
Wenonah,	35
Mt. Laurel-Navesink,	28
Red Bank,	19
Tinton,	11
Ripley Group, etc.,	44

This table does not exhibit the distinct alternation in the occurrence of the larger number of common species which was so conspicuously shown in the similar table for the Cliffwood fauna. The proper relationships of this fauna, however, are not clearly shown by this table, because the extensive collections which have been made in the Merchantville from one or two localities, have in many instances brought to light single individuals of species which occur abundantly in the Woodbury and more or less frequently in the recurring phases of the same fauna, but which are a negligible element in the Merchantville. Of the total 102 species recognized from the Merchantville, 44 have been noted from but a single locality, many of these being represented by single individuals, while 19 more are known from but two localities. As a whole the species which are common to the Merchantville and Woodbury fall into two groups, one group of species which occur rarely in the Merchantville and more commonly in the Woodbury, and a second group of species which occur more or less abundantly in the Merchantville and rarely in the Woodbury. When the more conspicuous elements in these two faunas are compared, it is found that they are distinctly different. The large number of species common to the two faunas, therefore, does not prove their complete unity, but rather demonstrates that, while living contemporaneously, they were not separated by an impassable barrier, that they occupied adjacent areas where somewhat different physical conditions obtained, and that occasionally a species best adapted to one environment wandered into the area of the other.

Notwithstanding the large number of species present in the Merchantville fauna which are more normally members of the *Lucina cretacea* fauna, there is a distinct element which is recurrent in the Marshalltown, Mount Laurel-Navesink, and Tinton, as may be seen by the following list.

	C	M	W	Ma	We	N	R	T
Cucullaea antrosa	—	×	—	—	—	×	—	×
Cucullaea neglecta	—	×	—	—	—	×		
Axinea subaustralis	—	×	—	—	—	×	—	×
Neithea quinquecostata	—	×	—	×	—	×		
Paranomia scabra	—	×	—	×	—	×		
Cardium spillmani	—	×	—	—	—	×		
Turnus kümmeli	—	×	—	×				
Martesia cretacea	—	×	—	×				
Pyropsis richardsoni	—	×	—	—	—	×		
Rostellites nasutus	—	×	—	—	—	×		
Callianassa mortoni	—	×	—	—	—	×	—	×

Besides the above list of species which have not as yet been observed at all in the intermediate stages, the species of the following list fall into the same general category, their occurrence in the intermediate stages being sporadic in nature, in all cases being much less common in the intermediate formations than in the Merchantville-Marshalltown-Navesink-Tinton horizons.

	C	M	W	Ma	We	N	R	T
Nemodon eufaulensis	—	×	—	×	—	×	×	×
Pinna laqueata	—	×	×	—	—	×		
Gervilliopsis ensiformis	—	×	×	—	—	×		
Inoceramus proximus	×	×	—	×				
Lima reticulata	—	×	—	×	×	×	×	×
Cardium tenuistriatum	—	×	—	×	×	×		
Panopea decisa	—	×	×	—	×	×	×	
Lunatia halli	—	×	—	—	×	×		
Gyrodes petrosa	—	×	—	—	×	×		
Baculites ovatus	—	×	×	—	—	×		

The forms which are perhaps the most characteristic of the Merchantville fauna and its recurrent phases, are *Axinea subaustralis* and the species of the genus *Cucullaea,* especially *C. antrosa,* and as a matter of convenience this recurrent fauna may be spoken of as the *Cucullaea* fauna.

CHAPTER V.

THE WOODBURY CLAY.

The Woodbury formation is a black clay, somewhat micaceous, not sandy in the lower portion but slightly so in the upper part where it is at times distinctly laminated. The formation is easily differentiated from the subjacent Merchantville by reason of the general absence of glauconite, except at the very base where the transition from the Merchantville occupies a thickness of from one to four feet.

The weathering of this formation is quite distinct in appearance from that of the Merchantville, the weathered product being a dove-colored or light chocolate-colored clay, which breaks into innumerable blocks, large and small, frequently exhibiting conchoidal fracture. The lower portion of the formation is often penetrated by numerous joints, which are sometimes filled with crusts of limonite. These sometimes form huge honey-comb-like masses many feet in diameter and tons in weight.

The thickness of the Woodbury clay varies from 55 feet in Monmouth County to something less than that along the Delaware.

FAUNA OF THE WOODBURY CLAY.

The fauna of the Woodbury clay is extensive, and more or less complete collections have been made at six localities distributed from Lorillard, in Monmouth County, to the vicinity of Haddonfield in Camden County, a distance of about 60 miles. The essential characteristics of the fauna occur throughout the entire extent of the formation. In the northern portion of the area the fossils occur in ferruginous, concretionary nodules, while in the more southern localities they occur directly in the clay, usually in the condition of internal casts and impressions of the exterior, but from one locality near Haddonfield, as shown by a collection

made many years ago and now preserved in the Philadelphia Academy of Science, the shells themselves are perfectly preserved. The local faunas which have been studied will be noted in order according to their localities, from the northeast to the southwest.

[1] *Locality 102*[2].—The National Fireproofing Company operate extensive clay pits at Lorillard, east of Keyport, in the Woodbury clay. In the deepest portion of the pit, south of the railroad tracks, about 20 feet of black clay is dug. At about the middle of the bank, through a thickness of from three to five feet, numerous concretionary nodules occur, ranging in size from a foot or more in diameter, down to a few inches, which are thrown aside as the clay is excavated with the steam-shovel. While embedded in the clay these nodules are of a dark, ash-gray color, but on exposure they gradually weather to a reddish-brown and become harder. They are abundantly fossiliferous and have afforded a large fauna, as follows:

ANTHOZOA.

Micrabacia americana M. & H.

ECHINODERMATA.

Hemiaster kümmeli Clark n. sp.

BRACHIOPODA.

Lingula subspatulata H. & M.

PELECYPODA.

Nucula percrassa Con.
Nucula whitfieldi n. sp.
Leda compressifrons (Whitf.).
Yoldia longifrons (Con.)
Nemodon conradi Johns.
Cucullaea woodburyensis n. sp.
Breviarca saffordi (Gabb).
Breviarca cuneata (Gabb).
Nemoarca cretacea Con.

[1] See p. 47 for Locality 102[1].

Axinea congesta (Con.).
Ostrea tecticosta Gabb.?
Pecten burlingtonensis Gabb.
Pecten argillensis Con.
Pecten conradi (Whitf.).
Plicatula woodburyensis n. sp.
Lima lorillardensis n. sp.
Anomia argentaria Mort.
Anomia radiata n. sp.
Modiola julia Lea.
Anatina jerseyensis n. sp.
Anatimya anteradiata Con.
Cymella bella Con.
Veniella conradi Mort.
Scambula perplana Con.
Lucina cretacea Whitf.
Tenea parilis Con.
Cardium dumosum Con.
Cardium ripleyanum Con.
Cardium lorillardensis n. sp.
Cardium whitfieldi n. sp.
Cardium uniformis n. sp.
Cyprimeria cretacea Con.
Legumen planulatum (Con.).
Linearia ornatissima n. sp.
Solyma lineolata Con.
Mactra pentangularis n. sp.
Corbula lorillardensis n. sp.
Corbula crassiplica Gabb.
Pholas cithara Mort.

SCAPHOPODA.

Dentalium subarcuatum Con.
Cadulus obrutus Con.

GASTROPODA.

Amauropsis meekana Whitf.
Turritella lorillardensis n. sp.

Laxispira lumbricalis Gabb.
Triton lorillardensis n. sp.
Pyropsis lorillardensis n. sp.
Fusus lorillardensis n. sp.
Cryptorhytis obliquicostata Gabb.
Cancellaria subalta Con.
Cancellaria smocki n. sp.
Actaeon gabbana Whitf.

CEPHALOPODA.

Placenticeras placenta (DeKay).
Scaphites nodosus (Owen).
Baculites ovatus Say.

CRUSTACEA.

Tetracarcinus subquadratus Weller.

Locality 103.—At Farry's brickyards, east of Matawan, the Woodbury clay is the raw material used. Numerous ferruginous nodules are imbedded in the clay at this locality, which are usually smaller, more irregular, harder and redder in color than those at Lorillard. Fossils are numerous in these nodules and the following species have been identified:

ANTHOZOA.

Micrabacia americana M. & H.

PELECYPODA.

Nucula whitfieldi n. sp.
Yoldia longifrons (Con.)
Yoldia papyria (Con.).
Nemodon sp.
Trigonarca cuneiformis Con.
Breviarca saffordi (Gabb).
Nemoarca cretacea Con.
Axinea congesta (Con.).
Ostrea tecticosta Gabb.?
Trigonia eufaulensis Gabb.

Pecten conradi (Whitf.)
Anomia argentaria Mort.
Modiola julia Lea.
Pholadomya occidentalis Mort.
Anatina jerseyensis n. sp.
Cymella bella Con.
Eryphyla conradi (Whitf.).
Vetericardia crenalirata Con.
Lucina cretacea Whitf.
Tenea parilis Con.
Cardium dumosum Con.
Cardium ripleyanum Con.
Isocardia cliffwoodensis Weller.
Cyprimeria cretacea Con.
Peronaeoderma georgiana Gabb.
Linearia metastriata Con.
Linearia ornatissima n. sp.
Solyma lineolata Con.
Cymbophora lintea (Con.).
Corbula bisulcata Con.
Corbula foulkei Lea.

SCAPHOPODA.

Dentalium subarcuatum Con.

GASTROPODA.

Amauropsis meekana Whitf.
Gyrodes sp.
Turritella lorillardensis n. sp.
Turritella quadrilirata Johns.
Anchura pergracilis Johns.
Volutomorpha biplicata (Gabb).?
Cancellaria subalta Con.
Cancellaria smocki n. sp.
Actaeon gabbana Whitf.

CEPHALOPODA.

Placenticeras placenta (Dekay).
Scaphites nodosus (Owen).
Baculites ovatus Say.

VERTEBRATA.

Shark's teeth.

Locality 168.—The next locality which has yielded a good fauna from the Woodbury clay, is at J. Braislin & Son's clay pits, at the village of Crosswicks, on Crosswicks Creek, east of Bordentown. This locality is about 30 miles, along the strike, from the localities already mentioned at Lorillard and Matawan. The fauna collected is composed of the following species:

BRACHIOPODA.

Lingula subspatulata H. & M.

PELECYPODA.

Nucula whitfieldi n. sp.
Leda compressifrons (Whitf.).
Yoldia longifrons (Con.).
Breviarca saffordi Gabb.
Nemoarca cretacea Con.
Pecten conradi Whitf.
Anomia argentaria Mort.
Lucina cretacea Whitf.
Cardium ripleyanum Con.
Cyprimeria cretacea Con.
Legumen planulatum (Con.).
Corbula crassiplica Gabb.
Panopea decisa Con.
Pholas cithara Mort.

SCAPHOPODA.

Dentalium subarcuatum Con.

GASTROPODA.

Margarita abyssima Gabb.
Turritella lorillardensis n. sp.
Anchura rostrata (Gabb).
Cancellaria subalta Con.

CEPHALOPODA.

Scaphites sp.

Locality 183.—In 1858 the fossil remains of a Dinosaur, *Hadrosaurus foulkii* Leidy, were described from near Haddonfield, and in the process of excavating the bones of this creature a large and important collection of fossil invertebrates was secured[1]. This Haddonfield material differed from most of the Cretaceous fossils which had previously been discovered in New Jersey in that the shell substance itself was perfectly preserved. This Haddonfield collection furnished the material from which many new species were described by Conrad, Gabb, Lea and others, and the types of these species, with the remaining material of the Haddonfield collection, are now preserved in the collections of the Philadelphia Academy of Science. The exact locality from which the material was secured is about 1 mile a little east of north from Haddonfield, in a small tributary ravine to Cooper's Creek, which joins the main stream from the west almost exactly opposite the mouth of the North Branch of the creek. No material has been secured from this locality during the recent operations of the Survey, and the following list of species is compiled entirely from the collections in the Philadelphia Academy of Science.

ANTHOZOA.

Micrabacia americana M. & H.

BRACHIOPODA.

Lingula subspatulata H. & M.

PELECYPODA.

Nucula percrassa Con.
Nucula whitfieldi n. sp.
Leda compressifrons Con.
Leda eufaulensis Gabb.
Leda pinnaformis Whit. (not Gabb).

[1] Proc. Acad. Nat. Sci. Phil., (1858), p. 213.

Perrisonota protexta Con.
Yoldia longifrons Con.
Yoldia papyria (Con.)
Nemodon conradi Johns.
Trigonarca cuneiformis Con.
Nemoarca cretacea Con.
Pinna laqueata Con.
Gervilliopsis ensiformis Con.
Pteria navicula Whitf.
Ostrea denticulifera Con.
Trigonia eufaulensis Gabb.
Pecten burlingtonensis Gabb.
Pecten argillensis Con.
Pecten conradi Whitf.
Modiola julia Lea.
Pholadomya occidentalis Mort.
Veniella conradi Mort.
Eriphyla conradi (Whitf.)
Eriphyla decemnaria Con.
Scambula perplana Con.
Vetericardia crenalirata Con.
Lucina cretacea Whitf.
Tenea parilis Con.
Cardium dumosum Con.
Cardium ripleyanum Con.
Cyprimeria cretacea Con.
Meretrix cretacea (Con.).
Legumen planulatum (Con.).
Linearia metastriata Con.
Tellinimera eborea Con.
Œnonia eufaulensis Con.
Œnonia papyria Con.
Leptosolen biplicatus Con.
Solyma lineolatus Con.
Cymbophora lintea (Con.).
Corbula crassiplica Gabb.
Corbula foulkei Lea.

SCAPHOPODA.

Dentalium subarcuatum Con.
Cadulus obrutus Con.

GASTROPODA.

Leiostraca cretacea Con.
Obeliscus conellus Whitf.
Scala sp.
Amauropsis meekana Whitf.
Gyrodes crenata Con.
Turritella lenolensis n. sp.
Laxispira lumbricalis Gabb.
Anchura rostrata (Gabb).
Pyropsis octōlirata Con.?
Euthria ? fragilis Whitf.
Cancellaria subalta Con.

Locality 165.—At Dobbs' clay-pits, 1.5 miles northwest of Haddonfield and about 1 mile southeast of Collingswood station, the Woodbury clay is well exposed. The fossils at this locality are all casts and moulds, the shell substance having been removed by solution, and their condition of preservation is poor. The following species, however, have been recognized:

BRACHIOPODA.

Lingula subspatulata H. & M.

PELECYPODA.

Leda compressifrons (Whitf.).
Perrisonota protexta Con.
Yoldia longifrons (Con.).
Yoldia papyria (Con.).
Nemoarca cretacea Con.
Pecten conradi (Whitf.).
Modiola julia Lea.
Cymella bella Con.
Lucina cretacea Whitf.
Tenea parilis Con.

Cardium ripleyanum Con.
Cyprimeria cretacea Con.
Cymbophora lintea (Con.).
Corbula crassiplica Gabb.
Corbula swedesboroensis n. sp.

GASTROPODA.
Turritella sp.
Anchura rostrata (Gabb).
Cryptorhytis obliquicostata Gabb.

CEPHALOPODA.
Scaphites sp.

Locality 164.—This locality is at the crossroads about ¼ mile southwest of Dobbs' clay-pits. The material was collected from a gully in a field to the west of the corner, and the following species have been recognized:

BRACHIOPODA.
Lingula subspatulata H. & M.

PELECYPODA.
Yoldia longifrons (Con.).
Yoldia papyria (Con).
Pecten conradi (Whitf.).
Lucina cretacea Whitf.
Tenea parilis Con.
Cardium ripleyanum Con.
Cymbophora lintea (Con.).
Corbula crassiplica Gabb.
Corbula lorillardensis n. sp.
Panopea decisa Con.

GASTROPODA.
Amauropsis meekana Whitf.
Turritella sp.
Anchura rostrata Gabb.
Cancellaria subalta Con.

TABLE OF DISTRIBUTION FOR THE WOODBURY FAUNA.

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Yoldia longifrons (Con.)	—	—	6	—	—	—	—	—	—	—	—	—	×
Pecten conradi (Whitf.)	—	5	6	—	—	—	2	—	—	—	—	—	
Lucina cretacea Whitf.	2	—	6	—	—	—	—	2	—	—	—	—	×
Cardium ripleyanum Con.	2	4	6										
Lingula subspatulata H & M.	—	—	5	—	—	—	—	—	—	—	—	—	×
Nemoarca cretacea Con.	—	4	5	—	—	1	—	1	—	—	—	—	
Tenea parilis Con.	1	2	5	—	—	2	2	2	1	—	—	—	×
Cyprimeria cretacea Con.	1	—	5	—	—	1							
Corbula crassiplica Gabb.	—	5	5	—	—	2	1	2	—	—	—	—	×
Cancellaria subalta Con.	—	1	5										
Nucula whitfieldi n. sp.	1	3	4	—	—	2	—	2					
Leda compressifrons Whitf.	—	3	4										
Yoldia papyria (Con.)	—	—	4										
Modiola julia Lea.	—	1	4	—	—	—	—	—	—	—	—	—	
Cymbophora lintea (Con.)	5	3	4	—	1	2	—	3	1	—	—	—	×××
Dentalium subarcuatum Con.	—	4	4	—	—	—	—	—	—	—	—	—	×
Amauropsis meekana Whitf.	—	1	4										
Anchura rostrata (Gabb)	—	3	4	—	—	1	—	—	—	—	—	—	×
Micrabacia americana M. & H.	—	1	3	—	—	1	—	—	—	—	—	—	××
Breviarca saffordi (Gabb)	—	—	3										
Anomia argentaria Mort.	2	6	3	—	2	1	3	1	—	—	—	—	×××
Cymella bella Con.	1	1	3	—	—	1	—	—	—	—	—	—	×
Cardium dumosum Con.	—	—	3	—	—	1	—	1	—	—	—	—	
Legumen planulatum (Con.)	—	3	3	—	—	1	3	1	—	—	—	—	××
Solyma lineolata Con.	1	3	3	—	—	1	—	1	—	—	—	—	××
Turritella lorillardensis n.sp.	—	—	3										
Nucula percrassa Con.	1	3	2	—	1	1	—	—	—	—	—	—	×
Perrisonota protexta Con.	—	3	2	—	—	1	—	3	1				
Nemodon conradi Johns.	—	—	2										
Trigonarca cuneiformis Con.	—	1	2										
Axinea congesta (Con.)	4	—	2	—	—	1	—	—	—	—	—	—	×
Ostrea tecticosta Gabb.?	—	1	2	—	—	1							
Trigonia eufaulensis Gabb.	—	2	2	—	—	2	—	—	—	—	—	—	×
Pecten burlingtonensis Gabb.	—	3	2	—	—	1							
Pecten argillensis Con.	—	3	2	—	1	1	2	—	—	—	—	—	××
Pholadomya occidentalis Mort.	2	4	2	—	—	—	—	—	—	—	—	—	×××
Veniella conradi Mort.	—	5	2	—	1	2	4	3	1	—	—	—	×

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Eriphyla conradi (Whitf.)	—	5	2										
Scambula perplana Con.	—	—	2	—	—	1							
Vetericardia crenalirata Con.	—	1	2	—	—	—	—	—	—	—	—	—	×
Linearia metastriata Con.	1	3	2	—	1	1	—	1	—	—	—	—	×
Linearia ornatissima n.sp.	—	—	2										
Corbula lorillardensis n.sp.	—	—	2										
Corbula foulkei Lea.	—	—	2										
Panopea decisa Con.	—	4	2	—	—	1	3	1	—	—	—	—	×
Pholas cithara Mort.	—	1	2	—	—	1	—	—	—	—	—	—	×
Cadulus obrutus Con.	—	—	2										
Laxispira lumbricalis Gabb.	—	3	2	—	—	—	—	—	—	—	—	—	×
Cryptorhytis obliquicostata Gabb.	—	—	2	—	—	—	—	—	—	—	—	—	×
Cancellari smocki n.sp.	—	1	2	—	—	—	—	—	—	—	—	—	×
Actaeon gabbana Whitf.	—	—	2										
Placenticeras placenta (DeKay)	1	4	2	—	1	2	—	—	—	—	—	—	×
Scaphites nodosus (Owen)	—	—	2	—	—	—	—	—	—	—	—	—	×
Baculites ovatus Say.	—	1	2	—	—	—	6	—	—	—	—	—	×
Hemiaster kümmeli Clark n. sp.	—	—	1										
Leda eufaulensis Gabb.	—	—	1										
Leda pinnaformis Whitf. (not Gabb)	—	—	1										
Cucullaea woodburyensis n. sp.	—	—	1										
Breviarca cuneata (Gabb)	—	2	1	—	—	—	—	—	—	—	—	—	×
Pinna laqueata Con.	—	2	1	—	—	—	3	—	—	—	—	—	×
Gervilliopsis ensiformis Con.	—	1	1	—	—	1	3	1	—	—	—	—	×
Pteria navicula Whitf.	—	—	1	—	—	—	—	1					
Ostrea denticulifera Con.	—	—	1	—	—	—	—	—	—	—	—	—	×
Lima lorillardensis n.sp.	—	—	1										
Anomia radiata n.sp.	—	2	1										
Anatina jerseyensis n.sp.	—	1	1	—	—	1							
Anatimya anteradiata Con.	—	—	1	—	—	1	—	—	—	—	—	—	×
Eriphyla decemnaria Con.	—	—	1										
Cardium lorillardensis n.sp.	—	—	1										
Cardium whitfieldi n.sp.	—	—	1										
Cardium uniformis n.sp.	—	—	1										
Isocardia cliffwoodensis Weller.	5	—	1	—	—	1	—	—	—	—	—	—	×
Meretrix cretacea (Con.)	—	—	1	—	1								
Peronaeoderma georgiana Gabb.	—	—	1	—	—	1	—	1	—	—	—	—	×
Tellinimera eborea Con.	—	3	1	—	—	2	—	1	—	—	—	—	×
Œnonia eufaulensis Con.	—	—	1	—	—	—	—	—	—	—	—	—	×
Œnonia papyria Con.	—	—	1										
Leptosolen biplicatus Con.	1	3	1	—	—	2	3	3	—	—	—	—	×
Mactra pentangularis n.sp.	—	—	1										
Corbula bisulcata Con.	3	3	1	—	—	—	—	—	—	—	—	—	×

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Corbula swedesboroensis n.sp.	1	1	1	—	1								
Margarita abyssima Gabb.	—	1	1	—	—	—	9	—	1				
Leiostraca cretacea Con.	—	—	1										
Obeliscus conellus Whitf.	—	—	1										
Gyrodes crenatus Con.	—	4	1	—	—	1	—	—	—	—	—	—	×
Turritella quadrilirata Johns.	2	—	1										
Turritella lenolensis n.sp.	—	1	1										
Anchura pergracilis Johns.	1	—	1										
Triton lorillardensis n.sp.	—	—	1										
Pyropsis octolirata Con. ?	—	—	1	—	—	—	—	—	—	—	—	—	×
Pyropsis lorillardensis n.sp.	—	—	1										
Euthria ? fragilis Whitf.	—	—	1										
Fusus lorillardensis n.sp.	—	—	1										
Volutoderma biplicata (Gabb)	—	1	1	—	1	1							
Tetracarcinus subquadratus Weller	2	—	1										

ANALYTICAL DISCUSSION OF THE WOODBURY FAUNA.

The data recorded in the preceeding table may be summarized as follows to show the number of species common to the Woodbury and to each of the other formations in the series. Thirty-two of the species, or 33 per cent., which have been recognized in the Woodbury, have not been seen in any other horizon, which leaves 63 species having a greater range.

Cliffwood,	21
Merchantville,	49
WOODBURY,	95
Marshalltown,	10
Wenonah,	35
Mt. Laurel-Navesink,	13
Red Bank,	19
Tinton,	5
Ripley Group, etc.,	43

The largest number of Woodbury species recognized in the fauna of any other member of this series of formations, is found

in the subjacent Merchantville clay. The facts in regard to the large community of species in these two formations have already been touched upon in some detail under the discussion of the Merchantville fauna, and need not be repeated at this place, except to say that the most conspicuous species of each fauna are either totally wanting or are exceedingly rare in the other one. The most characteristic species of the Woodbury clay are *Lingula subspatulata, Yoldia longifrons, Lucina cretacea,* and *Cyprimeria cretacea,* and not one of these has yet been observed anywhere in the Merchantville. On the other hand, *Axinea subaustralis* which is so abundant, and characteristic of the Merchantville does not occur at all in the Woodbury, and the genus *Cucullaea* is represented only by a single individual in all the collections which have been studied from the higher bed.

In passing to the faunas of the higher formations in the series, a distinct alternation in the number of species common to the Woodbury is shown, similar to the alternation of faunas to which attention has been called in connection with the discussion of the Cliffwood fauna, the Wenonah and Red Bank faunas having more in common with the Woodbury than do the Marshalltown, Mount Laurel-Navesink and Tinton. The following list of species shows the alternation in the occurrence of members of the *Lucina cretacea* fauna of the Woodbury, and to this list might be added several others whose occurrence in the intermediate formations is only sporadic.

	C	M	W	Ma	We	N	RB	T
Axinea congesta	×	—	×	—	×			
Pteria navicula	—	—	×	—	—	—	×	
Anatimya anteradiata	—	—	×	—	×			
Scambula perplana	—	—	×	—	×			
Lucina cretacea	×	—	×	—	—	—	×	
Cardium dumosum	—	—	×	—	×	—	×	
Isocardia cliffwoodensis	×	—	×	—	×			
Cyprimeria cretacea	×	—	×	—	×			
Peronaeoderma georgiana	—	—	×	—	×	—	×	
Turritella quadrilirata	×	—	×					
Anchura pergracilis	×	—	×					
Tetracarcinus subquadratus	×	—	×					

Besides that element in the Woodbury fauna which is recurrent in the Wenonah or Red Bank, a large element, 32 species in all, has as yet been recognized nowhere in New Jersey outside of the Woodbury. Among these species which are restricted entirely to the Woodbury we find one, *Yoldia longifrons,* which has been identified from every locality which has afforded a Woodbury fauna, and which, at Lorrillard where the most extensive collections have been made from this formation, is one of the most abundant species individually. Another species of this same sort is *Cancellaria subalta* which has been identified from each of the Woodbury localities but one, and which is again an abundant species in the Lorillard collection. This species, however, has one occurrence in the Merchantville, although but a single individual has been observed in a large collection.

A notable characteristic of the Woodbury fauna shown in following it from the more northern to the more southern localities, is the decrease in average size of some of the more abundant species. A group of species occurring both at Lorillard and near Haddonfield, and including such characteristic forms as *Yoldia longifrons, Lucina cretacea, Cyprimeria cretacea, Cancellaria subalta* and others, are conspicuously larger in the former locality than in the latter, the largest individuals at Lorillard being fully twice the size of the largest individuals of the same species at Haddonfield. The reason for this difference is doubtless to be found in the varying local conditions of environment at the time when the faunas occupied the region, the more northern part of the area furnishing more congenial surroundings for the robust development of the typical *Lucina cretacea* fauna than the region further south. In this same connection it may be noted that the differentiation between the Merchantville and Woodbury faunas is more sharp at the north than at the south, the mingling of the species of the two faunas, already noted, being more conspicuous to the south.

CHAPTER VI.

THE ENGLISHTOWN[1] SAND.

The formation immediately overlying the Woodbury clay is the Englishtown sand. It is a white or yellow quartz sand, sometimes marked by delicate lines of red, which give it a highly variegated appearance. Locally, parts of the formation have been cemented with iron into rather massive beds of sandstone. Usually the formation is a clean, quartz sand, often closely resembling the sand on the present beaches, yet not infrequently it contains thin laminæ of fine, brittle clay, which contain no sand or grit, and towards the top of the formation there is a horizon at which a discontinuous bed of clay occurs locally.

This formation is thickest at the northeast and decreases gradually towards the southwest. In Monmouth County it has a thickness of over 100 feet, on Crosswicks Creek it has diminished to 30 or 35 feet, and at Swedesboro it hardly exceeds 20 feet. Beyond this last point it apparently disappears as a recognizable formation. The lithologic characteristics of the formation are the same where it is thin as where it is thicker, and it retains its integrity as a distinct bed which is readily recognizable from Atlantic Highlands to Salem County.

The differentiation of the formation from the subjacent Woodbury clay is rather sharp, the transition from the clay to the sand being accomplished in a thickness of two or three feet at the most. The formation passes upward by a somewhat rapid transition into the overlying glauconitic or sandy clay, so that its upward limit can be easily recognized.

As yet this formation has not afforded any fauna, not a single fossil of an sort having been detected in it.

[1] Formerly called Columbus.

CHAPTER VII.

THE MARSHALLTOWN CLAY-MARL.

This formation is more variable in its lithologic characteristics than any of the others lying above the Magothy, which have been mentioned. The variations in the formation are gradual, however, and there is no difficulty in tracing the formation from one place to another. It ranges from a sandy clay with little or no glauconite, to a clayey greensand marl which, in Salem County, has been dug for fertilizing purposes, and which was mistaken by Cook, in the early work of the Survey, for the Lower Marl, now called the Navesink. In Monmouth County the formation is chiefly a laminated, micaceous clay with thin seams of sand, glauconite grains being absent from it, except in the upper portion of the bed, and then the greensand is only locally conspicuous. Near Marshalltown, in Salem county, the formation is a nearly pure greensand marl, and was once extensively used for fertilizer. The thickness of the formation is probably between 30 and 40 feet, its transition into both the subjacent and superjacent formations is somewhat abrupt, and it can be easily recognized and mapped from Monmouth to Salem Counties wherever it is not too deeply buried by the Pleistocene formations.

FAUNA OF THE MARSHALLTOWN CLAY-MARL.

Fossils have been collected from the Marshalltown formation only in its more marly portions in the southern part of its area. The only collections made by the writer have been in the vicinity of Swedesboro, near which place one locality has afforded a large fauna in which the specimens have their actual shells perfectly preserved. This same fossiliferous horizon doubtless occurs elsewhere in the region. Credner[1] undoubtedly had the

[1] Zeitsch. der Deutch, Geolog. Gesell, vol. 22, p. 191 (1870).

same horizon in his "*Trigonia limbata* zone," his *T. limbata* being the shell recognized in this report as *T. thoracica*. Credner's chief locality was in a railroad cut near Woodbury, which afforded him an abundance of fossils at the time of his visit, prior to 1870, but although a careful search has been made for this locality during the recent operations of the Survey, it has not been detected. From an excavation near Wenonah, made some years ago, a marly clay filled with well-preserved fossil shells has been reported, which could only be the Marshalltown, although no collections were secured from there by the writer. Formerly, when the marl pits were being actively operated near Marshalltown, an abundance of fossils could be secured there, but none could be obtained during the prosecution of the field work in connection with the present report. From time to time in the future, however, these or other localities in the region will doubtless be opened up, and additional collections should be secured for comparative study.

Of the four localities, a record of whose faunas are here given, only one has been carefully worked. At locality 177 the better part of two weeks time was spent in an attempt to make as complete a collection as possible, while not over one hour was spent at either of the other three localities. In the case of the Marshalltown fauna, therefore, the recorded number of occurrences is not of so great importance as in the case of the faunas of those formations from which a larger number of careful collections have been made. However, those species which do occur at several of these localities may be safely considered as being among the conspicuous members of the fauna.

The local faunas which have been studied are as follows:

Locality 177.—By far the most important fossiliferous locality in the Marshalltown formation, from which collections have been secured during the recent operations of the Survey, is about 1 mile a little south of west from Swedesboro. The clay is well exposed in the banks of the brook in the woods at this locality, and the condition of preservation of the shells is exceptional for the Cretaceous beds of New Jersey, the shell substance itself be-

ing perfectly preserved. The shells are very abundant at this locality, the species which have been identified being as follows:

VERMES.

Serpula circularis n. sp.
Hamulus falcatus (Con.).

PELECYPODA.

Nucula percrassa Con.
Nemodon eufaulensis (Gabb).
Cucullaea tippana Con.
Inoceramus proximus Tuom.
Ostrea falcata Mort.
Ostrea plumosa Mort.
Gryphaea mutabilis Mort.
Gryphaeostrea vomer (Mort.).
Exogyra ponderosa Roem.
Trigonia thoracica Mort.
Neithea quinquecostata (Sow.).
Lima reticulata (L. & F.).
Lima whitfieldi n. sp.
Plagiostoma erecta (Whitf.).
Anomia argentaria Mort.
Paranomia scabra (Mort.).
Crenella serica Con.
Veniella conradi Mort.
Etea carolinensis Con.
Crassatellites subplanus (Con.).
Unicardium umbonata (Whitf.).
Lucina swedesboroensis n. sp.
Cardium tenuistriatum Whitf.
Cyprimeria excavata (Mort.).
Meretrix eufaulensis (Con.).
Meretrix cretacea (Con.).
Linearia metastriata Con.
Cymbophora lintea (Con.).
Corbula swedesboroensis n. sp.
Turnus kümmeli n. sp.
Martesia cretacea Gabb.

GASTROPODA.

Scala sillmani Mort.
Turritella tippana Con.
Turritella marshalltownensis n. sp.
Pyropsis sp.
Rapana stantoni n. sp.
Volutomorpha biplicata Gabb.

CEPHALOPODA.

Placenticeras placenta (DeKay).
Turrilites pauper Whitf.

Locality 180.—The Marshalltown clay-marl is exposed about 2.5 miles southwest of Swedesboro, and about the same distance northwest from Harrisonville station, near the headwaters of one of the tributaries of Old Man's Creek. The fauna here is much inferior to that last mentioned, both in number of species collected and in the state of their preservation. The following forms have been observed:

VERMES.

Serpula sp.

PELECYPODA.

Ostrea panda Mort.
Gryphaea mutabilis Mort.
Gryphaea convexa Mort.
Gryphaeostrea vomer (Mort.)
Neithea quinquecostata (Sow.)
Plagiostoma erecta (Whitf.).
Anomia argentaria Mort.
Cardium tenuistriatum Whitf.

GASTROPODA.

Pyropsis sp.
Odontofusus medians Whitf.

Locality 179.—A few fossils have been collected from the Marshalltown clay-marl just below the road at the foot of an old mill pond a little less than 1.5 miles northwest of Harrisonville station. The species which have been identified are as follows:

PELECYPODA.

Cucullaea tippana Con.
Gryphaea mutabilis Mort.
Pecten argillensis Con.
Pecten venustus Mort.
Neithea quinquecostata (Sow.).
Plagiostoma erecta (Whitf.).
Paranomia scabra (Mort.)

GASTROPODA.

Rostellites sp.

Locality 190.—In 1895 Mr. G. N. Knapp collected a small series of fossils in the Marshalltown clay-marl from Lloyd's marl pits at Marshalltown, and the following species have been identified:

PELECYPODA.

Cucullaea tippana Con.
Crassatellites subplanus (Con.).
Cardium tenuistriatum (Whitf.).

GASTROPODA.

Turritella sp.

TABLE OF DISTRIBUTION FOR THE MARSHALTOWN FAUNA.

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Cucullaea tippana Con.	—	—	—	—	3	1	2	2	3	—	—	—	×
Gryphaea mutabilis Mort.	—	—	—	—	3								
Neithea quinquecostata (Sow.)	—	2	—	—	3	—	3						
Plagiostoma erecta (Whitf.)	—	—	—	—	3	—	3						
Cardium tenuistriatum (Whitf.)	—	7	—	—	3	1	11						
Gryphaeostrea vomer (Mort.)	—	—	—	—	2	—	7	1					
Anomia argentaria Mort.	2	6	3	—	2	1	3	1	—	—	—	—	×
Paranomia scabra (Mort.)	—	1	—	—	2	—	4	—	—	—	—	—	×
Crassatellites subplanus (Con.)	—	—	—	—	2	1	7	1	4				
Nucula percrassa Con.	1	3	2	—	1	1	—	—	—	—	—	—	×
Nemodon eufaulensis (Gabb)	—	4	—	—	1	—	2	3	1	—	—	—	×
Inoceramus proximus Tuom.	2	5	—	—	1	—	—	—	—	—	—	—	×
Ostrea falcata Mort.	—	—	—	—	1	—	4	—	—	—	—	—	×
Ostrea plumosa Mort.	—	—	—	—	1	—	—	1	—	—	—	—	×
Ostrea panda Mort.	—	—	—	—	1	—	—	—	—	—	—	—	×
Gryphaea convexa Mort.	—	—	—	—	1	—	14	—	—	—	—	—	×
Exogyra ponderosa Roem.	—	—	—	—	1	—	—	—	—	—	—	—	×
Trigonia thoracica Mort.	—	—	—	—	1	1	1	—	—	—	—	—	×
Pecten argillensis Con.	—	3	2	—	1	1	2	—	—	—	—	—	×
Pecten venustus Mort.	—	—	—	—	1	—	8	3	3				
Lima reticulata (L. & F.)	—	2	—	—	1	1	8	2	1				
Lima whitfieldi n.sp.	—	—	—	—	1								
Crenella serica Con.	—	—	—	—	1	—	—	2	—	—	—	—	×
Veniella conradi Mort.	—	5	2	—	1	2	4	3	1	—	—	—	×
Etea carolinensis Con.	—	—	—	—	1	—	—	—	—	—	—	—	×
Unicardium umbonatum (Whitf.)	—	—	—	—	1	—	2						
Lucina swedesboroensis n.sp.	—	—	—	—	1	—	—	—	—	—	—	—	×
Cyprimeria excavata (Mort.)	—	—	—	—	1	—	—	—	—	—	—	—	×
Meretrix cretacea (Con.)	—	—	1	—	1								
Meretrix eufaulensis (Con.)	—	—	—	—	1	1	2	—	—	—	—	—	×
Linearia metastriata Con.	1	3	2	—	1	1	—	1	—	—	—	—	×
Cymbophora lintea (Con.)	5	3	4	—	1	2	—	3	1	—	—	—	×
Corbula swedesboroensis n.sp.	1	1	1	—	1								
Turnus kümmeli n.sp.	—	1	—	—	1								
Martesia cretacea Gabb.	—	1	—	—	1								
Scala sillmani Mort.	—	1	—	—	1	2	1	1	1	—	—	—	×
Turritella tippana Con.	—	—	—	—	1	—	—	—	—	—	—	—	×
Turritella marshalltownensis n.sp.	—	—	—	—	1								
Rapana stantoni n.sp.	—	—	—	—	1	—	—	—	—	—	—	—	×
Odontofusus medians Whitf.	—	—	—	—	1	—	3	—	—	—	—	—	×
Volutoderma biplicata Gabb.	—	1	1	—	1	1							
Placenticeras placenta (DeKay)	1	4	2	—	1	2	—	—	—	—	—	—	×
Turrilites pauper Whitf.	—	—	—	—	1	1							

ANALYTICAL DISCUSSION OF THE MARSHALLTOWN FAUNA.

The data recorded in the above table may be summarized as follows, in order to show the number of Marshalltown species common to each of the other faunas in the series. Of the total 43 species recognized, 10 or 23 per cent. are restricted to the Marshalltown fauna.

Cliffwood,	7
Merchantville,	18
Woodbury,	10
MARSHALLTOWN,	43
Wenonah,	16
Mt Laurel-Navesink,	20
Red Bank,	13
Tinton,	8
Ripley Group, etc.,	26

In the above summary table a distinct alternation in the relationship of the faunas, already noted, is shown, the Merchantville and Mount Laurel-Navesink faunas having more species in common with the Marshalltown than do the Woodbury and Wenonah, although the latter two formations are immediately subjacent and superjacent to the Marshalltown. The Tinton, however, does not in this table, show a closer relationship to the Marshalltown than does the Red Bank, although it will be shown later that the Tinton is much more closely allied to the Navesink than is the Red Bank.

The *Cucullaea* element in the Marshalltown fauna has a notable development, *C. tippana* being one of the most abundant species at locality 177. *Neithea quinquecostata* and *Cardium tenuistriatum* are other conspicuous species of the *Cucullaea* fauna which are recurrent from the Merchantville and take a conspicuous place in this fauna. *Axinea subaustralis,* one of the most characteristic members of the other manifestations of the *Cucullaea* fauna, as well as *Cucullaea antrosa* have not been observed in any of the collections which have been studied from the Marshalltown, although it is not improbable that they may yet be observed in future collections. The following list shows those species in the fauna which are recurrent from the Mer-

chantville or which reappear in the Mount Laurel-Navesink fauna without being present in the intervening Woodbury below or Wenonah above.

	C	M	W	Ma	We	N	RB	T
Ostrea falcata	—	—	—	×	—	×		
Gryphaea convexa	—	—	—	×	—	×		
Neithea quinquecostata	—	×	—	×	—	×		
Plagiostoma crecta	—	—	—	×	—	×		
Paranomia scabra	—	×	—	×	—	×		
Unicardium umbonatum	—	—	—	×	—	×		
Turnus kümmeli	—	×	—	×				
Martesia cretacea	—	×	—	×				
Odontofusus medians	—		—	×	—	×		

The most conspicuous characteristic in the Marshalltown fauna is a new element, which has not been present in any of the earlier faunas in this region and which may represent a new immigration into the Cretaceous area of New Jersey at this time, an element which persists in the recurrent *Cucullaea* faunas of later formations, and which has its most typical manifestation in the Mount Laurel-Navesink fauna. This element is represented most conspicuously by the ponderous species of *Exogyra* and *Gryphaea,* by the little oyster *O. falcata* which is of the type of *O. larva,* and by *Gryphaeostrea vomer.* In the Cliffwood, Merchantville and Woodbury formations these oyster-like shells are essentially absent. An occasional example of the internal cast of an *Exogyra,* much smaller than the usual full-grown representatives of this genus in the Marshalltown and Navesink faunas, occurs in the Merchantville, but no suggestion of the genus has been met with in the Woodbury. No examples at all of *Gryphaea* and *Gryphaeostrea* have been met with in these lower faunas, and only the merest suggestion of oysters of the type of *O. larva.* In strong contrast with the paucity of these forms in the faunas of the Cliffwood, Merchantville and Woodbury, their great abundance in the Marshalltown is a most striking characteristic of the fauna. The species of these shells are for the most part different from those of the same types in the Mount Laurel-Navesink fauna, *Exogyra ponderosa, Gryphaea mutabilis*

and *Ostrea falcata* of the Marshalltown being replaced by *Exogyra costatá, Gryphaea convexa,* and *Ostrea mesenterica* in the higher fauna, although *G. convexa* has been rarely observed in the Marshalltown, and *O. falcata* in the Mount Laurel-Navesink. The same species of *Gryphaeostrea, G. vomer* occurs in both faunas. Besides these oyster-like forms which so strongly characterize the Marshalltown and the Navesink, some other species should probably be included in the same faunal element, among which are the following species which are as yet known only from these two faunas: *Plagiostoma erecta, Unicardium umbonatum,* and *Odontofusus medians.* To these should also be added, in all probability, *Trigonia thoracica* which has been recognized in both the faunas and also in the intermediate Wenonah, where, however, only a single occurrence of a single individual has been observed.

The origin of this *Exogyra* element in the Marshalltown fauna of New Jersey is probably from the more southern gulf region where the genus *Exogyra* is widely distributed and very abundant. Furthermore the stratigraphic position of *E. ponderosa,* as regards *E. costata,* is the same in the south as in New Jersey.

CHAPTER VIII.

THE WENONAH SAND.

The Wenonah formation is usually a black or reddish-brown sand, sometimes strongly micaceous, and often having a peculiar mixture of pinkish, brown, or gray sand grains which give it a characteristic color. Locally it is distinctly laminated, with thin seams of black or chocolate-colored clay. The more ferruginous layers are sometimes cemented into a ferruginous sandstone, but cementation of this sort is less frequent than in the Englishtown sand. The formation sometimes contains small amounts of glauconite, but this substance is never conspicuous. The upper layers of the formation frequently contain coarse grains of quartz of the size of peas. In Monmouth County the formation is 50 or 55 feet in thickness and is sharply differentiated from both the subjacent and superjacent formations, but towards the south, the Wenonah and the superjacent Mount Laurel sand grow lithologically more similar and it is practically impossible to distinguish between them from lithologic characters alone, except under extremely favorable circumstances, and consequently it is not possible to make an accurate estimate of its thickness. The thickness of the two sand formations together, however, in Salem County is somewhat over 60 feet, though the Wenonah portion of the bed is probably materially thinner than in Monmouth County.

FAUNA OF THE WENONAH SAND.

The fauna of the Wenonah sand has been collected at only two localities, both of which are in Monmouth County.

At John Longstreet's marl pit, a little less than 1 mile southeast of Crawfords Corner, and 2¼ miles a little east of north from Holmdel, there is an excellent exposure of the higher beds of the Wenonah sand, with about 25 feet of the superjacent

Navesink marl (Locality 126). The section at this point, as made out by the writer is as follows, beginning at the base:

126[1]. Gray sand with dark clay bands 1 to 3 inches in thickness interbedded in the upper portion, ... 3 feet.

126[2]. Variegated red and yellow sand with many cylindrical bodies, lying in all directions, probably plant remains or burrows, ... 2 feet.

126[3]. A more or less discontinuous band of loosely indurated ferruginous sand, filled with fossils, ... ½ foot.

126[4]. Sand, yellow below, becoming gray above, the upper 3 feet with much fine gravel included. The top of the Wenonah sand formation, the upper 3 feet possibly representing the Mount Laurel, ... 9 feet.

126[5]. Dark, chocolate-colored, or nearly black greensand marl with no fossils, ... 10 feet.

126[6]. Much lighter colored, gray, greensand marl, no fossils observed, ... 1 foot.

126[7]. Gray, glauconitic marl like that of the bed beloy, but containing an abundance of fossils. In the lower portion of the bed the fossils are much less common, but they increase above until the upper 1 foot is a mass of *Gryphaea* shells, ... 2½ feet.

126[8]. Dark or nearly black greensand marl with no fossils except an occasional *Gryphaea* near the base, ... 6 feet.

126[9]. Lighter colored, gray marl to the top of the bank. No fossils observed, ... 6 feet.

Locality 126[3].—This layer in the Wenonah sand, at Longstreet's marl pits, is one of the few localities of this formation from which fossils have been secured. These fossils are all more or less imperfect internal casts and moulds, and aside from the species recognized in the following list, there are many others, especially among the gastropods, which are too imperfectly preserved to be identified. Including these unidentified forms, the entire fauna probably does not fall far short of 100 species. The species which it has been possible to identify are as follows:

ANTHOZOA.

Micrabacia americana M. & H.

ECHINODERMATA.

Fragment of undetermined Echinoid.

VERMES.

Hamulus ?? sp.

PELECYPODA.

Nucula whitfieldi n. sp.
Leda marlboroensis n. sp.
Nemodon brevifrons Con.?
Nemodon sp.
Arca rostellata Mort.
Axinea microdentus n. sp.
Inoceramus sp.
Pteria petrosa (Con.).
Ostrea subspatulata Forbes.
Ostrea plumosa Mort.
Trigonia eufaulensis Gabb.
Trigonia thoracica Mort.
Lima reticulata (L. & F.).
Lithophaga ripleyana Gabb.
Veniella conradi Mort.
Crassatellites cuneatus Gabb.
Tenea parilis Con.
Cardium dumosum Con.
Cardium eufaulensis Con.
Cardium longstreeti n. sp.
Meretrix tippana Con.
Meretrix eufaulensis (Con.).
Tellina georgiana Gabb.
Tellina sp.
Tellinimera eborea (Con.).
Leptosolen biplicata Con.
Cymbophora lintea (Con.).
Schizodesma appressa Gabb.
Corbula crassiplica Gabb.
Pholas cithara Mort.

GASTROPODA.

Scala sillmani Mort.
Lunatia halli Gabb.
Gyrodes crenata Con.
Gyrodes petrosus (Mort.).
Turritella trilira Con.
Turritella sp.
Anchura rostrata (Gabb).?
Pterocerella tippana (Con.).
Pugnellus densatus Con.?
Pyropsis retifer (Gabb).
Fusus holmesianus Gabb.
Turbinella alabamensis Gabb.
Volutoderma biplicata (Gabb).
Piestocheilus bella Gabb.?
Piestocheilus kanei Gabb.
Turbinopsis depressa Gabb.
Actaeon cretacea Gabb.
Cylichna recta Gabb.

CEPHALOPODA.

Placenticeras placenta (DeKay).

VERTEBRATA.

Shark's teeth, several species.
Enchodus sp. (teeth).

A little over 1 mile east of Marlboro, in the south bank of Hop Brook, just east of the wagon bridge across this stream, is an excellent exposure of the upper beds of the Wenonah sand and the superjacent Navesink marl, the Mount Laurel not being represented. The section shown at this locality (130) is as follows, beginning at the base:

130[1]. Black, micaceous and arenaceous clay, extending below the level of the brook. Fossils are abundant, but all are in the condition of casts. In the upper portion of the bed numerous quartz pebbles of the size of peas are scattered throughout the clay, ... 6 feet.

130[2]. Dark clay below, with more or less glauconite, the line of separation between this bed and the one below being ill-defined, but within 2 feet of the base the clay content has gradually disappeared and the bed is nearly pure greensand marl. Near the base of the bed the typical Navesink species, *Belemnitella americana*, makes its appearance, although it is not abundant, ... 6 feet.

130[3]. Greensand marl with numerous specimens of *Exogyra costata* and a smaller number of individuals of *Gryphaea convexa* and *Belemnitella americana*,.... 2 feet.

130[4]. Greensand marl with fossils less conspicuous than in the bed below, the white shells not being exposed upon the surface of the cliff, ... 4 feet.

130[5]. Greensand marl, crowded full of the shells of *Gryphaea convexa*, ... 1 foot.

130[6]. Nearly pure, dark, greensand marl below, becoming lighter in color above and mixed with yellowish or reddish sand, and gradually changing to the more typical beds of the Red Bank sand at the top of the bank, ... 20 feet.

Locality 130[1].—The lowermost bed in the above section, is at the summit of the Wenonah sand, this passes up into the Navesink marl, and at the very top of the bank is the base of the Red Bank sand. This locality abounds in fossils, and is within about a quarter of a mile from the locality which furnished a number of specimens for Whitfield, which are recorded in his monograph as coming from "micaceous clay under the Lower Green Sand at pits of Rev. G. C. Schanck, near Marlborough, New Jersey." The horizon is undoubtedly the same at the two localities, and all of the new species described by Whitfield from this "micaceous clay" have been detected in the more recent collections of the Survey. The fauna is a large one and the following species have been identified:

VERMES.

Hamulus falcatus (Con.)

BRACHIOPODA.

Lingula subspatulata M. & H.

PELECYPODA.

Nucula percrassa Con.
Nucula whitfieldi n. sp.
Leda marlboroensis n. sp.
Perrisonota protexta Con.
Nemodon brevifrons Con.
Cucullaea tippana Con.
Nemoarca cretacea Con.
Axinea congesta (Con.)
Gervilliopsis ensiformis Con.
Pteria petrosa (Con.).
Ostrea subspatulata Forbes.
Ostrea tecticosta Gabb.
Exogyra sp.
Trigonia eufaulensis Gabb.
Pecten quinquenaria Con.
Pecten burlingtonensis Gabb.
Pecten argillensis Con.
Anomia argentaria Mort.
Mytilus oblivius Whitf.
Modiola wenonah n. sp.
Pholadomya roemeri Whitf.
Anatina jerseyensis n. sp.
Anatimya anteradiata Con.
Liopistha protexta Con.
Cymella bella Con.
Cymella undata (M. & H.)
Cuspidaria ventricosa (M. & H.)
Crassatellites subplanus Con.
Crassatellites transversus Gabb.
Veniella conradi Mort.
Scambula perplana Con.
Tenea parilis Con.
Cardium wenonah n. sp.
Cardium tenuistriatum (Whitf.)

Isocardia cliffwoodensis Weller.
Cyprimeria cretacea Con.
Legumen planulatum (Con.)
Tellina georgiana Gabb.
Peronaeoderma georgiana Gabb.
Linearia metastriata Con.
Tellinimera eborea (Con.)
Leptosolen biplicata Con.
Solyma lineolata Con.
Cymbophora lintea (Con.)
Schizodesma appressa Gabb.
Corbula crassiplica Gabb.
Panopea decisa Con.

GASTROPODA.

Scala sillmani Mort.
Lunatia halli Gabb.
Gyrodes petrosa Mort.
Turritella trilira Con.
Nassa globosa Gabb.
Turbinella alabamensis Gabb.

CEPHALOPODA.

Placenticeras placenta (DeKay).
Pachydiscus complexus (H. & M.)
Turrilites pauper Whitf.

CRUSTACEA.

Callianassa sp.

TABLE OF DISTRIBUTION FOR THE WENONAH FAUNA.

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Nucula whitfieldi n. sp.	1	3	4	—	—	2	—	2					
Leda marlboroensis n. sp.	—	—	—	—	—	2							
Nemodon brevifrons Con.	1	—	—	—	—	2	—	—	—	—	—	—	X
Pteria petrosa (Con.)	3	—	—	—	—	2	—	—	—	—	—	—	X
Ostrea subspatulata Forbes	—	—	—	—	—	2	—	—	—	—	—	—	X
Trigonia eufaulensis Gabb.	—	2	2	—	—	2	—	—	—	—	—	—	X
Veniella conradi Mort.	—	5	2	—	1	2	4	3	1	—	—	—	X
Tenea parilis Con.	1	2	5	—	—	2	2	2	1	—	—	—	X
Tellina georgiana Gabb.	—	—	—	—	—	2	—	—	—	—	—	—	X
Tellinimera eborea (Con.)	—	3	1	—	—	2	—	1	—	—	—	—	X
Leptosolen biplicata Con.	1	3	1	—	—	2	3	3	—	—	—	—	X
Cymbophora lintea (Con.)	5	3	4	—	1	2	—	3	1	—	—	—	X
Schizodesma appressa Gabb.	2	—	—	—	—	2	—	—	—	—	—	—	X
Corbula crassiplica Gabb.	—	5	5	—	—	2	1	2	—	—	—	—	X
Scala sillmani Mort.	—	1	—	—	1	2	1	1	1	—	—	—	X
Lunatia halli Gabb.	—	1	—	—	—	2	14	—	—	—	—	—	X
Gyrodes petrosus (Mort.)	—	2	—	—	—	2	10	2	—	—	—	—	X
Turritella trilira Con.	—	—	—	—	—	2	—	—	—	—	—	—	X
Turbinella alabamensis Gabb.	—	—	—	—	—	2	4	—	—	—	—	—	X
Placenticeras placenta (DeKay)	1	4	2	—	1	2	—	—	—	—	—	—	X
Micrabacia americana M. & H.	—	1	3	—	—	1	—	—	—	—	—	—	X
Nucula percrassa Con.	1	3	2	—	1	1	—	—	—	—	—	—	X
Perrisonota protexta Con.	—	3	2	—	—	1	—	3	1				
Cucullaea tippana Con.	—	—	—	—	3	1	2	2	3	—	—	—	X
Arca rostellata Mort.	—	—	—	—	—	1							
Nemoarca cretacea Con.	—	4	5	—	—	1	—	1					
Axinea congesta (Con.)	4	—	2	—	—	1							
Axinea microdentus n.sp.	—	—	—	—	—	1							
Gervilliopsis ensiformis Con.	—	1	1	—	—	1	3	1	—	—	—	—	X
Ostrea plumosa Mort.	—	—	—	—	—	1							
Ostrea tecticosta Gabb.	—	1	2	—	—	1							
Trigonia thoracica Mort.	—	—	—	—	1	1	1	—	—	—	—	—	X
Pecten quinquenaria Con.	—	—	—	—	—	1	1	—	—	—	—	—	X
Pecten burlingtonensis Gabb.	—	3	2	—	—	1							
Pecten argillensis Con.	—	3	2	—	1	1	2	—	—	—	—	—	X
Lima reticulata (L. & F.)	—	2	—	—	1	1	8	2	1				
Anomia argentaria Mort.	2	6	3	—	2	1	3	1	—	—	—	—	X
Mytilus oblivius Whitf.	1	—	—	—	—	1							
Modiola wenonah n.sp.	—	—	—	—	—	1							
Lithophaga ripleyana Gabb.	—	—	—	—	—	1	4						

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Pholadomya roemeri Whitf.	—	—	—	—	—	1	—	—	—	—	—	—	—
Anatina jerseyensis n.sp.	—	1	1	—	—	1	—	—	—	—	—	—	—
Anatimya anteradiata Con.	—	—	1	—	—	1	—	—	—	—	—	—	—
Liopistha protexta Con.	—	—	—	—	—	1	6	3	1	—	—	—	X
Cymella bella Con.	1	1	3	—	—	1	—	—	—	—	—	—	X
Cymella undata (M. & H.)	—	—	—	—	—	1	—	—	1	—	—	—	X
Cuspidaria ventricosa (M. & H.)	—	—	—	—	—	1	—	3	1	—	—	—	X
Crassatellites transversus Gabb.	—	—	—	—	—	1	—	—	—	—	—	—	—
Crassatellites subplanus Con.	—	—	—	—	2	1	7	1	4	—	—	—	—
Crassatellites cuneatus Gabb.	—	3	—	—	—	1	—	—	—	—	—	—	—
Scambula perplana Con.	—	—	2	—	—	1	—	—	—	—	—	—	—
Cardium dumosum Con.	—	—	3	—	—	1	—	1	—	—	—	—	—
Cardium wenonah n.sp.	—	—	—	—	—	1	—	1	—	—	—	—	X
Cardium tenuistriatum (Whitf.)	—	7	—	—	3	1	11	—	—	—	—	—	X
Cardium eufaulensis Con.	—	—	—	—	—	1	—	—	—	—	—	—	X
Cardium longstreeti n.sp.	—	—	—	—	—	1	—	—	—	—	—	—	X
Isocardia cliffwoodensis Weller	5	—	1	—	—	1	—	—	—	—	—	—	X
Cyprimeria cretacea Con.	1	—	5	—	—	1	—	—	—	—	—	—	—
Meretrix tippana Con.	1	3	—	—	—	1	—	—	—	—	—	—	—
Meretrix eufaulensis (Con.)	—	—	—	—	1	1	2	—	—	—	—	—	X
Legumen planulatum (Con.)	—	3	3	—	—	1	3	1	—	—	—	—	X
Peronaeoderma georgiana Gabb.	—	—	1	—	—	1	—	1	—	—	—	—	X
Linearia metastriata Con.	1	3	2	—	1	1	—	1	—	—	—	—	X
Solyma lineolata Con.	1	3	3	—	—	1	—	1	—	—	—	—	X
Panopea decisa Con.	—	4	2	—	—	1	3	1	—	—	—	—	X
Pholas cithara Mort.	—	1	2	—	—	1	—	—	—	—	—	—	X
Gyrodes crenata Con.	—	4	1	—	—	1	—	—	—	—	—	—	X
Anchura rostrata (Gabb).?	—	3	4	—	—	1	—	—	—	—	—	—	X
Pterocerella tippana (Con.)	—	—	—	—	—	1	—	—	—	—	—	—	X
Pugnellus densatus Con.?	—	—	—	—	—	1	—	—	—	—	—	—	X
Pyropsis retifer (Gabb)	—	—	—	—	—	1	2	—	—	—	—	—	—
Nassa globosa Gabb.	—	—	—	—	—	1	—	—	—	—	—	—	X
Fusus holmesianus Gabb.	—	—	—	—	—	1	—	—	—	—	—	—	X
Volutoderma biplicata (Gabb)	—	1	1	—	1	1	—	—	—	—	—	—	—
Piestocheilus bella Gabb.?	—	—	—	—	—	1	—	—	—	—	—	—	—
Piestocheilus kanei Gabb.	1	—	—	—	—	1	—	—	—	—	—	—	—
Turbinopsis depressa Gabb.	—	—	—	—	—	1	3	—	—	—	—	—	—
Actaeon cretacea Gabb.	—	—	—	—	—	1	2	1	—	—	—	—	—
Cylichna recta Gabb.	—	—	—	—	—	1	1	—	—	—	—	—	—
Pachydiscus complexus (H. & M.)	—	—	—	—	—	1	—	—	—	—	—	—	X
Turrilites pauper Whitf.	—	—	—	—	—	1	1	—	—	—	—	—	—

ANALYTICAL DISCUSSION OF THE WENONAH FAUNA.

The data recorded in the preceding table may be summarized as follows, 19 of the Wenonah species, or 23 per cent., not being recorded from any other horizon:

Cliffwood,	19
Merchantville,	35
Woodbury,	35
Marshalltown,	15
WENONAH,	81
Mt. Laurel-Navesink,	26
Red Bank,	26
Tinton,	10
Ripley Group, etc.,	50

Although in this summary table the same number of Wenonah species seem to be present in both the Woodbury and the Merchantville, the most characteristic members of the *Cucullaea* fauna which are so abundant in the Merchantville are either absent, or are exceedingly rare in the Wenonah, and when this fact is taken into consideration, the relationship of the Wenonah fauna is seen to be much closer with the Woodbury than with any other fauna in the entire series. This summary table also shows the same number of Wenonah species common to the Mount Laurel-Navesink and the Red Bank, although a later table will show that a larger number of Red Bank species are present in the Wenonah than in the Mount Laurel-Navesink fauna. Here also, when the most highly characteristic and abundant Mount Laurel-Navesink species are taken into account, it is seen that they are conspicuous for their absence, or great rarity, in the Wenonah, and in reality the fauna is much more closely allied to the Red Bank than to the Mount Laurel-Navesink fauna.

Several of the species common to the Wenonah and the Mount Laurel-Navesink appear for the first time in the Wenonah, and do not persist, so far as has been observed, beyond the Navesink. These species are: *Pecten quinquenaria, Lithophaga ripleyana, Pyropsis retifer, Turbinopsis depressa, Turbinella alabamensis*

and *Cylinchna recta*, and to these may be added the following, which occur also in the Marshalltown: *Trigonia thoracica*, *Meretrix eufalensis* and *Actaeon cretacea*, all of which are apparently more truly members of the Marshalltown-Navesink fauna than of the Wenonah. The great exogyras and gryphaeas, with *Ostrea falcata* and *Gryphaeostrea vomer*, which are so abundant in the Marshalltown and which either recur or are represented by closely-allied species in the Mount Laurel-Navesink, are entirely absent from the Wenonah.

CHAPTER IX.

THE MOUNT LAUREL-NAVESINK FORMATIONS.

In the bluff at Atlantic Highlands the Mount Laurel formation includes from 3 to 5 feet of quartz sand, with some glauconite, the "sand marl" of Cook, and has afforded an abundance of fossils. Immediately above this bed at the same locality there are 10 or 11 feet of typical, nearly pure greensand, the Navesink marl, although the entire Navesink formation is not exposed here, its total thickness in the region of its typical development in eastern Monmouth County being about 30 feet. In the region where it is typically developed the Navesink marl is sharply defined below, but towards its summit it gradually passes into a layer of darker color, with less glauconite and with more sandy clay, sometimes micaceous, the transition to the superjacent Red Bank sand being somewhat gradual. About 10 feet from the base of the Navesink, in eastern Monmouth County, a conspicuous shell layer about one foot in thickness and composed almost entirely of the shells of *Gryphaea convexa* is a very constant feature of the formation.

In the southwestern extension of the Mount Laurel and Navesink formations the lower sand formation apparently increases in thickness at the expense of the upper greensand marl formation, until it is probable that the entire interval occupied in eastern Monmouth County by the two formations is occupied by the Mount Laurel sand alone.

FAUNA OF THE MOUNT LAUREL-NAVESINK FORMATIONS.

The faunas of the Mount Laurel sand and the Navesink marl constitute a single unit, and in any discussion of them they must be considered together. Collections of this fauna have been made

from 22 localities during the recent operations of the Survey, and these will be noted in regular geographical order, so far as it can be done, beginning with the northeastern portion of the area and proceeding to the southwest. The collections from these different localities, however, have not been equally complete, and in only a few places have conditions been such as to allow the formation of exhaustive collections.

The most northeasterly locality from which the Navesink fauna has been collected, is at Atlantic Highlands, in the bluff along the shore of Raritan Bay, east of the railroad station. The section here (Locality 108), is as follows, beginning at the base:

108[1]. Laminated sand and clay with little or no glauconite, usually of a gray color; the Wenonah sand,..... 40 feet.

108[2]. Moderately coarse quartz sand with more or less glauconite, fossils abundant; the Mount Laurel sand, ... 3 feet.

108[3]. Dark greenish, greensand marl, with a line of concretions at the base,..... 11 feet.

108[4]. Yellow sand and gravel. Pensauken.

Locality 108[2].—At the time this locality was visited by the writer, the conditions were not favorable for making a large collection of fossils, but a collection of material from the same locality, preserved in the State Museum at Trenton, has been available for study, and has supplied many species not collected by the writer. Prof. R. P. Whitfield, of the American Museum of Natural History in New York, has visited the locality frequently and has accumulated a large representation of the fauna, which is now preserved in the collections of the American Museum. This collection contains a number of species not observed by the writer. The long list of fossils published by Prather[1] from Atlantic Highlands are all from this same fossil bed, although many of his identifications are manifestly incorrect, and his stratigraphy is muddled beyond all possibility of interpretation. The fossil bed at this point is the basal or "sand marl" division of the Lower Marl of Cook[2], being the Mount

[1] Am. Geol., vol. 36, pp. 168-171.
[2] Geol. N. J. (1868), p. 263.

Laurel division of the Monmouth group, in the classification of Clark. The species which have been identified in the collections that have been available for study are as follows:

BRACHIOPODA.

Terebratella plicata Say.

PELECYPODA.

Cucullaea antrosa Mort.
Cucullaea tippana Con.
Cucullae neglecta Gabb.
Arca uniopsis Con.
Gerveilliopsis ensiformis (Con.).
Ostrea mesenterica Mort.
Ostrea sp.
Exogyra costata Say.
Trigonia thoracica Mort.
Neithea quinquecostata Lam.
Lima reticulata L. & F.
Paranomia scabra Mort.
Corimya tenuis Whitf.
Clavagella armata Mort.
Liopistha protexta Con.
Veniella conradi Mort.
Crassatellites subplana (Con.).
Unicardium umbonatum (Whitf.).
Cardium spillmani Con.
Cardium tenuistriatum (Whitf.).
Cardium trilineatum n. sp.
Legumen planulatum Con.
Panopea decisa Con.

GASTROPODA.

Lunatia halli Gabb.
Lunatia sp.
Gyrodes abyssima Mort.
Gyrodes petrosa Mort.
Gyrodes sp.

Xenophora leprosa Mort.
Turritella vertebroides Mort.
Turritella encrinoides Mort.
Anchura pennata Mort.
Rostellaria fusiformis Whitf.
Rostellaria curta Whitf.?
Cypraea mortoni Gabb.
Trachytriton atlanticum Whitf.
Pyrifusus mullicaensis (Gabb.)
Pyropsis trochiformis (Tuom.).
Pyropsis richardsoni (Tuom.).
Pyropsis septemlirata Gabb.
Pyropsis sp.
Serrifusus crosswickensis Whitf.
Odontofusus medians Whitf.
Odontofusus sp.
Turbinella alabamensis Gabb.
Turbinella parva Gabb.
Volutoderma ovata Whitf.
Volutomorpha conradi Gabb.
Volutomorpha ponderosa Whitf.
Piestochilus sp.
Rostellites angulatus Whitf.
Turbinopsis depressa Gabb.
Turbinopsis curta Whitf.
Turbinopsis ? sp.
Morea plicata (Whitf.)?
Cithara mullicaensis Whitf.
Actaeon cretacea Gabb.
Haminea mortoni (Forbes).

CEPHALOPODA.

Heteroceras conradi Mort.
Baculites ovatus Say.
Belemnitella americana Mort.

VERTEBRATA.

Fish vertebræ.
Bone of reptile.
Coprolite.

In a marl pit at Middletown (Locality 113), a little more than ½ mile west of the railroad station, the sandy Mount Laurel bed (113^1) is poorly exposed in the gullies by the roadside, the typical Navesink (113^2) being well shown in the excavation a little higher up.

Locality 113^1.—This bed is more or less calcareous, with rounded quartz pebbles the size of peas. The exposure is not well adapted for the collection of fossils and only a few species, all more or less fragmentary, have been identified, as follows:

PELECYPODA.

Gryphaea sp.
Exogyra costata Say.
Pecten sp.
Gastrochaena ? (tube).

GASTROPODA.

Anchura pennata Mort.
Pyrifusus mullicaensis (Gabb).

Locality 113^2.—The fossils here occur in a grayish, greensand marl, which has been dug for fertilizing purposes. The species which have been identified are as follows:

BRACHIOPODA.

Terebratella plicata Say.

PELECYPODA.

Cucullaea neglecta Gabb.
Ostrea mesenterica Mort.
Gryphaea convexa Mort.
Exogyra costata Say.

Dianchora echinata Mort.
Anomia argentaria Mort.
Cardium tenuistriatum (Whitf.).

GASTROPODA.

Margarita abyssima (Gabb).
Lunatia halli Gabb.
Gyrodes petrosus (Mort.).
Turritella encrinoides Mort.
Anchura pennata (Mort.).
Pyropsis trochiformis (Tuom.).
Piestochilus mucronata Gabb.
Rostellites nasutus Gabb.
Cithara mullicaensis Whitf.

CEPHALOPODA.

Belemnitella americana Mort.

Locality 121.—At a locality in the Navesink marl about ¼ of a mile south of Oak Hill, and about 1¾ miles south of Middletown, no complete collection was made, but the following species occur abundantly:

BRACHIOPODA.

Terebratella plicata Say.

PELECYPODA.

Ostrea mesenterica Mort.

Locality 120.—In the bank of a small ravine on the east side of the New York and Long Branch Railroad, 1¼ miles northwest of the Red Bank station, the lower portion of the Navesink marl is exposed and has yielded the following fauna:

PELECYPODA.

Cucullaea neglecta Gabb.
Ostrea mesenterica Mort.
Ostrea nasuta Mort.

Ostrea falcata Mort.
Gryphaeostrea vomer (Mort.)
Exogyra costata Say.
Pecten quinquenaria Con.
Lima reticulata (L. & F.)
Cardium tenuistriatum (Whitf.)

GASTROPODA.
Lunatia halli Gabb.
Pyropsis retifer (Gabb).
Pyropsis sp.
Cithara mullicaensis Whitf.

Locality 126[T].—The section at this locality, Longstreet's marl pit near Crawford's Corner, has already been given (See p. 92). This fossiliferous bed in the Navesink marl is limited to about 2.5 feet, the fossils being sparsely represented below although a larger number of species are present there than in the upper one foot of the bed, which is a mass of shells of *Gryphaea convexa* with some examples of *Ostrea mesenterica*, these being essentially the only species present. The fauna from this locality is the largest which has been collected from the Navesink marl proper, although a larger number of species have been recognized from the Mount Laurel facies at Atlantic Highlands. The species which have been recognized at this locality are as follows:

ECHINODERMATA.
Spine of echinoid.

BRACHIOPODA.
Terebratella plicata Say.

PELECYPODA.
Cucullaea antrosa Mort.
Cucullaea neglecta Gabb.
Axinea subaustralis (d'Orb.).
Pinna laqueata Con.
Ostrea mesenterica Mort.

Ostrea monmouthensis n.sp.
Gryphaea convexa Mort.
Exogyra costata Say.
Pecten venustus Mort.
Pecten conradi Whitf.
Spondylus gregalis Mort.
Lima pelagica Mort.
Lima reticulata (L. & F.)
Plagiostoma erecta (Whitf.)
Anomia argentaria Mort.
Mytilus smocki n.sp.
Corimya tenuis Whitf.
Clavagella armata Mort.
Liopistha protexta Con.
Cuspidaria jerseyensis n.sp.
Veniella conradi Mort.
Caprotina jerseyensis n.sp.
Cardium tenuistriatum (Whitf.)
Panopea decisa Con.

GASTROPODA.

Pleurotomaria crotaloides (Mort.)
Margarita abyssima (Gabb).
Scala sillmani Mort.
Lunatia halli Gabb.
Gyrodes abyssima (Mort.)
Gyrodes petrosa Mort.
Xenophora leprosa Mort.
Turritella vertebroides Mort.
Turritella encrinoides Mort.
Anchura pennata (Mort.)
Anchura abrupta Con.
Perissolax dubia (Gabb).
Pyropsis trochiformis (Tuom.)
Odontofusus typicalis Whitf.
Turbinella alabamensis Gabb.
Turbinella parva Gabb.
Piestochilus mucronatus Gabb.

Rostellites nasutus Gabb.
Cithara Mullicaensis Whitf.
Cithara sp.
Haminea mortoni (Forbes).

CEPHALOPODA.
Belemnitella americana Mort.

VERTEBRATA.
Crocodile scutes.

Henry Conover's marl pit is situated a little over 1.5 miles a little west of north from Holmdel. The Navesink fauna at this point occurs in two zones in the marl, the association of species being somewhat different in each. The following section has been recognized at this locality (Locality 128).

128^1. At the edge of the brook north of the marl pit the dark Wenonah sand is exposed, its depth being unknown.

128^2. Dark greensand marl, no fossils, ... 4 feet.

128^3. Gray, brown or dark greensand marl, with many fossils, ... 2 feet.

128^4. Greensand marl, barren or but sparsely fossiliferous, ... 3 feet.

128^5. Greensand marl with many fossil *Gryphaea* shells and other fossils, ... 1 foot.

128^6. Greensand marl without fossils to top of bank, 15 feet.

Locality 128^3.—The lowermost fossiliferous zone in Henry Conover's marl pit is marked by the common occurrence of *Terebratella vanuxemi*, a species which has not been recognized elsewhere, in the recent operations of the Survey. *T. plicata* occurs also, but it is a rare species in this bed, becoming much more abundant in the higher fauna in the same section. The complete fauna recognized here is as follows:

ECHINODERMATA.
Echinoid spines.

BRACHIOPODA.

Terebratella vanuxemi L. & F.
Terebratella plicata Say.

PELECYPODA.

Nemodon sp.
Inoceramus confertim-annulatus Roemer.
Meleagrinella abrupta (Con.).
Gryphaea convexa Mort.
Exogyra costata Say.
Pecten venustus Mort.
Pecten sp.
Dianchora echinata Mort.
Plagiostoma erecta (Whitf.)
Crassatellites sp.
Cardium tenuistratum (Whitf.)

GASTROPODA.

Gyrodes petrosus (Mort.)
Turritella sp.

CEPHALOPODA.

Belemnitella americana Mort.

Locality 128[5].—In the higher fossiliferous zone in the same marl pit, the following species have been identified:

BRACHIOPODA.

Terebratella plicata Say.

PELECYPODA.

Cucullaea neglecta Gabb.
Ostrea mesenterica Mort.
Gryphaea convexa Mort.
Lima pelagica Mort.
Cardium tenuistriatum (Whitf.)
Cyprimeria sp.

GASTROPODA.

Lunatia halli Gabb.
Turritella encrinoides Mort.
Anchura pennata (Mort.)
Pyropsis trochiformis (Tuom.)
Rostellites nasutus Gabb.

CEPHALOPODA.

Belemnitella americana Mort.

Locality 127.—Edgar Schanck's marl pit is situated a little less than ½ mile southwest from that of Henry Conover, and about 1.5 miles northwest of Holmdel. The bank from which marl has been dug is about 16 feet in height, and was largely covered with talus at the time it was visited by the writer. Examples of *Gryphaea convexa* and *Ostrea mesenterica* are abundant in the disintegrated marl of the talus slope. By digging through the disintegrated material it was found that the fossiliferous zone is apparently restricted to a thickness of about three feet near the mid-height of the entire exposure. In the lower portion of this zone the fossils are somewhat sparsely scattered through the marl, and the large *Gryphaea* shells are inconspicuous, but in the upper part these shells become more abundant, and at the very top of the zone there occurs a conspicuous shell bed about one foot in thickness made up almost exclusively of the shells of *Gryphaea convexa.* The entire fauna collected at this locality is as follows:

BRACHIOPODA.

Terebratella plicata Say.

PELECYPODA.

Cucullaea neglecta Gabb.
Ostrea mesenterica Mort.
Gryphaea convexa Mort.
Exogyra costata Say.
Pecten venustus Mort.
Cardium tenuistriatum (Whitf.)

GASTROPODA.

Turritella encrinoides Mort.
Anchura pennata Mort.
Pyropsis trochiformis (Tuom.)
Turbinella parva Gabb.
Rostellites nasutus Gabb.

CEPHALOPODA.

Belemnitella americana Mort.

Locality 194.—At John Holmes' marl pit, 1 mile northwest of Holmdel, no attempt was made to make a complete collection, but the following species were recognized during a few minutes' visit to the locality:

BRACHIOPODA.

Terebratella plicata Say.

PELECYPODA.

Ostrea mesenterica Mort.
Gryphaea convexa Mort.
Exogyra costata Say.

CEPHALOPODA.

Baculites ovatus Say.
Belemnitella americana Mort.

Locality 131.—In Obadiah Herbert's marl pit, just east of the village of Marlboro, an extensive exposure of the Navesink marl may be seen. At the time this locality was visited by the writer, however, the pit was not being operated, and little opportunity was afforded for the collection of fossils. The following species which were secured, doubtless represent but a small percentage of the entire fauna, which might be collected under more favorable conditions:

BRACHIOPODA.

Terebratella plicata Say.

PELECYPODA.

Cucullaea neglecta Gabb.
Ostrea mesenterica Mort.
Gryphaea convexa Mort.
Gryphaeostrea vomer (Mort.).
Pecten venustus Mort.
Lithophaga ripleyana (Gabb.).
Cardium tenuistriatum (Whitf.)

CEPHALOPODA.

Belemnitella americana Mort.

Locality 133.—In an old marl pit 3 miles west of Freehold, and 1 mile a little east of south from Tennants station, at the head waters of a small tributary of Wemrock Brook, the lower portion of the Navesink is shown, and the following species of fossils have been collected:

PELECYPODA.

Cucullaea antrosa Mort.
Gervilliopsis ensiformis (Con.)
Inoceramus confertim-annulatus Roemer.
Exogyra costata Say.
Pecten venustus Mort.
Pecten tenuitestus Gabb.

GASTROPODA.

Margarita abyssima (Gabb.).
Lunatia halli Gabb.
Turritella encrinoides Mort.
Anchura pennata (Mort.).
Trachytriton atlanticum Whitf.
Volutomorpha conradi Gabb.
Cinulia naticoides Gabb.

CEPHALOPODA.

Belemnitella americana Mort.

VERTEBRATA.

Shark's tooth.

Enchodus (tooth).

Along the road leading up the hill south of Walnford, the Mount Laurel sand and Navesink marl are exposed, the transition from the pure red or yellow sand to the sandy marl being gradual.

Locality 148[1].—The lower portion of the section at this locality is a pure quartz sand, stained with iron to a bright orange or yellow color. Fossils occur in these beds, but they are for the most part poorly preserved, about the only species represented being *Ostrea falcata* Mort., and a small, convex *Gryphaea*-like shell, all in the condition of casts. A little higher up the beds gradualy become more glauconitic, but are much decomposed. In addition to the species already mentioned, *Plicatula urticosa* Mort., *Paranomia scabra* Mort., and *Belemnitella americana* have been detected in this higher portion of the bed. These fossils are distributed through 10 feet or more of strata.

Locality 148[2].—Lying above these beds already mentioned, there is three feet, more or less, of ferruginous, sandy, highly decomposed greensand marl, exposed in the gullies by the road side near the top of the hill, which is abundantly fossiliferous. There is, however, no sharp line between this bed and the subjacent one. The fauna collected from this bed comprises the following species:

BRACHIOPODA.

Terebratella plicata Say.

VERMES.

Hamulus lineatus n. sp.

PELECYPODA.

Nemodon eufaulensis Gabb.

Cucullaea antrosa Mort.

Axinea subaustralis (d'Orb.).

Pinna laqueata Con.

Gryphaea convexa Mort.
Exogyra costata Say.
Trigonia sp.
Plicatula urticosa Mort.
Spondylus gregalis Mort.
Lima reticulata (L. & F.).
Lithophaga ripleyana (Gabb).
Liopistha protexta Con.
Veniella trigona Gabb.
Crassatellites subplanum (Con.).
Cardium spillmani Con.
Cyprimeria sp.
Meretrix eufaulensis Con.
Corbula crassiplica Gabb.

GASTROPODA.

Margarita abyssima (Gabb).
Lunatia halli Gabb.
Gyrodes petrosus (Mort.)
Turritella encrinoides Mort.
Anchura pennata Mort.
Trachytriton atlanticum Whitf.
Volutomorpha conradi Gabb.
Turbinopsis depressa Gabb.

CEPHALOPODA.

Baculites ovatus Say.
Belemnitella americana Mort.

CRUSTACEA.

Callianassa mortoni Pilsb.

VERTEBRATA.

Shark's tooth.

Locality 149.—From a natural outcrop of the Navesink marl in a tributary of Crosswicks Creek, about 1 mile south of the last locality, the following species have been collected:

BRACHIOPODA.

Terebratella plicata Say.

VERMES.

Hamulus lineatus n. sp.

PELECYPODA.

Cucullaea antrosa Mort.
Arca uniopsis Con.
Axinea subaustralis (d'Orb.).
Ostrea mesenterica Mort.
Gryphaea convexa Mort.
Gryphaeostrea vomer (Mort.)
Exogyra costata Say.
Pecten venustus Mort.
Pecten tenuitestus Gabb.
Pecten whitfieldi n. sp.
Pecten argillensis Con.?
Lima pelagica Mort.
Lima reticulata (L. & F.).
Plagiostoma erecta (Whitf.)
Mytilus smocki n. sp.
Liopistha protexta Con.
Veniella conradi Mort.
Veniella trigona Gabb.
Crassatellites subplanum (Con.).
Cardium tenuistriatum (Whitf.).
Legumen planulatum Con.

GASTROPODA.

Margarita abyssima (Gabb).
Delphinula sp.
Lunatia halli Gabb.
Gyrodes petrosus Mort.
Turritella vertebroides Mort.
Turritella encrinoides Mort.
Anchura pennata (Mort.)
Triton precedens Whitf.

Trachytriton atlanticum Whitf.
Pyrifusus mullicaensis (Gabb).
Odontofusus typicus Whitf.
Odontofusus medians Whitf.
Turbinopsis curta Whitf.?
Actaeon cretacea Gabb.

CEPHALOPODA.
Belemnitella americana Mort.

CRUSTACEA.
Callianassa mortoni Pilsb.

Locality 147.—This locality is situated about ¾ of a mile south of the last, and about 2¾ miles northwest of New Egypt. The beds are the lower portion of the Navesink marl and are exposed in the bank of a tributary of Crosswicks Creek which joins the main stream almost opposite the mouth of Lahaway Creek, just east of the wagon road, about ⅓ of a mile from Crosswicks Creek. Several distinct beds may be recognized.

147[1]. This is a gray sand exposed in the bank of the creek about 90 yards east of the bridge. No fossils were obtained from it and its depth was not determined. It should probably be referred to the Wenonah sand.

147[2]. This is a gray, arenaceous bed, one foot in thickness, with very little glauconite, containing vast numbers of *Belemnitella, Gryphaea* and *Exogyra,* examples of all these species being of exceptionally large size. The number of species present in the fauna is small, as follows:

PELECYPODA.
Ostrea falcata Mort.
Gryphaea convexa Mort.
Exogyra costata Say.
Neithea quinquecostata (Sow.).

CEPHALOPODA.
Belemnitella americana Mort.

147[3]. Lying above the bed containing such an abundance of *Belemnitella* there are about 18 inches of gray, sandy marl, whose fauna contains a larger number of species, although the number of individuals is very much smaller. The following species have been identified:

PELECYPODA.

Cucullaea antrosa Mort.
Exogyra costata Say.
Pecten whitfieldi n. sp.
Veniella trigona Gabb.
Tenea paralis Con.
Cardium spillmani Con.

GASTROPODA.

Margarita abyssima (Gabb.).
Lunatia halli Gabb.
Anchura pennata Mort.

CEPHALOPODA.

Belemnitella americana Mort.

147[4]. This bed is about 1 foot in thickness and contains a larger fauna than either of the two lower horizons. It is still a sandy marl, but the glauconite content is larger than in the beds below. In the fauna of this bed *Gryphaea* is again abundant, but *Belemnitella* is one of the less common species. The following species have been identified:

BRANCHIOPODA.

Terebratella plicata Say.

VERMES.

Hamulus lineatus n. sp.

PELECYPODA.

Cucullaea antrosa Mort.
Axinea subaustralis (d'Orb.).

Inoceramus confertim-annulatus Roemer.
Ostrea mesenterica Mort.
Gryphaea convexa Mort.
Gryphaeostrea vomer Mort.
Exogyra costata Say.
Trigonia sp.
Pecten tenuitestus Gabb.
Pecten argillensis Con.
Lima pelagica (Mort.).
Lima reticulata (L. & F.).
Anomia argentaria Mort.
Paranomia scabra Mort.
Veniella trigona Gabb.
Crassatellites subplanus (Con.).
Unicardium umbonatum (Whitf.).
Cardium spillmani Con.
Meretrix eufaulensis (Con.).

GASTROPODA.

Margarita abyssima Gabb.
Lunatia halli Gabb.
Gyrodes abyssima Mort.
Gyrodes petrosus Mort.
Turritella vertebroides Mort.
Anchura pennata Mort.
Pyropsis retifer (Gabb.)
Turbinella alabamensis Gabb.
Volutomorpha conradi Gabb.
Cithara mullicaensis Whitf.

CEPHALOPODA.

Baculites ovatus Say.
Belemnitella americana Mort.

Locality 195.—In the immediate neighborhood of the locality last described, are Bruere's marl pits, which furnished a number of specimens used by Whitfield in the preparation of his mono-

graph. A collection in the State Museum at Trenton, ascribed to this locality, has been available for study by the writer in which the following species have been identified:

ECHINODERMATA.

Echinoid spine

BRANCHIOPODA.

Terebratella plicata Say.
Terebratella vanuxemi L. & F.

VERMES.

Hamulus lineatus n. sp.

PELECYPODA.

Cucullaea antrosa Mort.
Arca uniopsis Con.
Axinea subaustralis (d'Orb.).
Inoceramus confertim-annulatus Roemer.
Ostrea falcata Mort.
Ostrea mesenterica Mort.
Ostrea sp.
Gryphaea convexa Mort.
Gryphaeostrea vomer Mort.
Exogyra costata Say.
Pecten venustus Mort.
Pecten whitfieldi n. sp.
Neithea sp.
Spondylus gregalis Mort.
Lima reticulata (L. & F.).
Paranomia scabra Mort.
Lithophaga ripleyana (Gabb.).
Corimya tenuis Whitf.
Liopistha protexta Con.
Venella trigona Gabb.
Crassatellites subplanus (Con.).
Tenea parilis Con.
Cardium spillmani Con.

Cardium tenuistriatum (Whitf.).
Cyprimeria sp.
Legumen planulatum (Con.).
Leptosolen biplicata Con.
Panopea decisa Con.
Gastrochaena whitfieldi n. sp.

GASTROPODA.

Margarita abyssima Gabb.
Lunatia halli Gabb.
Lunatia ? pauperata (Whitf.).
Lunatia sp.
Gyrodes petrosus Mort.
Xenophora leprosa Mort.
Turritella encrinoides Mort.
Turritella vertebroides Mort.
Anchura pennata Mort.
Anchura abrupta Con.
Trachytriton atlanticum Whitf.
Perissolax dubia Gabb.
Pyrifusus mullicaensis Gabb.
Pyropsis whitfieldi n. sp.
Odontofusus typicus Whitf.
Odontofusus medians Whitf.
Turbinella parva Gabb.
Volutoderma ovata Whitf.
Piestochilus mucronatus (Gabb).
Piestochilus bella (Gabb).
Piestochilus sp.
Rostellites nasutus Gabb.
Turbinopsis depressa Gabb.
Turbinopsis elevata Whitf.
Cithara mullicaensis Whitf.
Cithara sp.

CEPHALOPODA.

Baculites ovatus Say.
Belemnitella americana Mort.

CRUSTACEA.

Callianassa mortoni Pilsb.

Locality 150.—From an exposure of the Navesink marl, 1¼ miles northwest of Jacobstown, and about 1½ miles southwest of Arneytown, the following fauna has been identified:

BRACHIOPODA.

Terebratella plicata Say.

VERMES.

Hamulus lineatus n. sp.

PELECYPODA.

Nemodon eufaulensis (Gabb).
Cucullaea antrosa Mort.
Cucullaea tippana Con.
Arca sp.
Axinea subaustralis (d'Orb.).
Pinna laqueata Con.
Ostrea mesenterica Mort.
Gryphaea convexa Mort.
Gryphaeostrea vomer Mort.
Exogyra costata Say.
Pecten whitfieldi n. sp.
Lima pelagica Mort.
Liopistha sp.
Crassatellites subplana Mort.
Cardum spillmani Con.
Cardium sp.
Leptosolen biplicata Con.

GASTROPODA.

Margarita abyssima Gabb.
Lunatia halli Gabb.
Gyrodes petrosa Mort.
Xenophora leprosa Mort.

Turritella encrinoides Mort.
Turritella vertebroides Mort.
Anchura pennata Mort.
Triton precedens Whitf.
Trachytriton sp.
Volutomorpha gabbi Whitf.
Cinulia naticoides Gabb.

CEPHLAPODA.

Nautilus dekayi Mort.
Belemnitella americana Mort.

CRUSTACEA.

Callianassa mortoni Pilsb.

Locality 166.—An exposure by the roadside, 1 mile southwest of Mount Laurel, is arenaceous with some calcareous material, but with no glauconite, and it may evidently be referred to the Mount Laurel. This locality has yielded the following fauna:

PELECYPODA.

Cucullaea antrosa Mort.
Axinea subaustralis (d'Orb.).
Gryphaeostrea vomer Mort.
Exogyra costata Say.
Pecten craticulus Mort.?
Cardium tenuistriatum (Whitf.).

GASTROPODA.

Lunatia halli Gabb.
Turritella vertebroides Mort.
Anchura pennata Mort.
Pyrifusus mullicaensis (Gabb).
Volutomorpha conradi Gabb.

CEPHALOPODA.

Belemnitella americana Mort.

Mullica Hill has long been a noted locality for New Jersey Cretaceous fossils. The fossil locality is in the village, the exposure being in the hillside just south of the railroad trestle. The section at this point is as follows (Locality 169) from the base upward.

169^1. Yellow or red quartz sand without glauconite, about 20 feet exposed at the base of the bluff. The contained fossils are poorly preserved casts, but *Belemnitella americana, Gryphaea* and *Neithea* have been recognized, and the bed may be confidently referred to the Mount Laurel sand.

169^2. Above the yellow sand is a 5-foot, indurated shell bed, filled with fossils. The matrix in which the fossils are imbedded is sandy, with pea-like quartz pebbles, the whole colored dark-green by a considerable percentage of glauconite. The shells of those species which are not represented by casts, have for the most part been replaced by the mineral *vivianite,* a phosphate of iron doubtless derived from the glauconite.

169^3. Above the shell bed, a nearly pure greensand marl continues to the summit of the exposure.

Locality 169^2.—The fauna of the shell bed exposed at Mullica Hill has yielded the following species, although the list is doubtless incomplete:

ANTHOZOA.

Paracyathus vaughani n. sp.
Undetermined coral.

ECHINODERMATA.

Cardiaster smocki Clark n. sp.

BRACHIOPODA.

Terebratella plicata Say.

PELECYPODA.

Cucullaea neglecta Gabb.
Gervilliopsis ensiformis (Con.).
Inoceramus confertim-annulatus Roemer.

Ostrea mesenterica Mort.
Gryphaea convexa Mort.
Exogyra costata Say.
Trigonia sp.
Pecten venustus Mort.
Pecten conradi Whitf.
Neithea quinquecostata (Sow.)
Plicatula mullicaensis n. sp.
Dianchora echinata Mort.
Lima pelagica Mort.
Lima reticulata (L. & F.).
Lima sp.
Lithophaga ripleyana (Gabb).
Corimya tenuis Whitf.
Liopistha protexta (Con.).
Veniella conradi Mort.
Crassatellites subplanus (Con.).
Cardium kümmeli n. sp.
Teredo sp.

GASTROPODA.

Pleurotomaria crotaloides (Mort.)
Lunatia halli Gabb.
Gyrodes abyssima (Mort.)
Gyrodes petrosa Mort.
Turritella encrinoides Mort.
Anchura pennata Mort.
Anchura ? sp.
Perissolax dubia (Gabb).
Pyrifusus mullicaensis (Gabb).
Pyrifusus macfarlandi Whitf.
Pyropsis trochiformis (Tuom.).
Pyropsis septemlirata Gabb.
Odontofusus typicus Whitf.
Turbinella alabamensis Gabb.
Volutomorpha conradi Gabb.
Piestochilus sp.
Turbinopsis elevata Whitf.

CEPHALOPODA.

Nautilus dekayi.

Baculites ovatus Say.

Belemnitella americana Mort.

TABLE OF DISTRIBUTION FOR THE MOUNT LAUREL-NAVESINK FAUNA.

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Belemnitella americana Mort	—	—	—	—	—	—	19	—	—	—	—	—	×
Exogyra costata Say	—	—	—	—	—	—	18	1	2	—	—	—	×
Terebratella plicata Say	—	—	—	—	—	—	15						
Anchura pennata Mort	—	—	—	—	—	—	15	—	1	—	—	—	×
Ostrea mesenterica Mort	—	—	—	—	—	—	14	2	2				
Gryphaea convexa Mort	—	—	—	—	1	—	14	—	—	—	—	—	×
Lunatia halli Gabb	—	1	—	—	—	2	14	—	—	—	—	—	×
Cardium tenuistriatum (Whitf.)	—	7	—	—	3	1	11						
Turritella encrinoides Mort	—	—	—	—	—	—	11	—	—	—	—	—	×
Cucullaea antrosa Mort	—	4	1	—	—	—	10	—	1	—	—	—	×
Gyrodes petrosus Mort	—	2	—	—	—	2	10	2	—	—	—	—	×
Margarita abyssima (Gabb)	—	1	1	—	—	—	9	—	1				
Cucullaea neglecta Gabb	—	1	—	—	—	—	8	—	—	—	—	—	×
Pecten venustus Mort	—	—	—	—	1	—	8	3	3				
Lima reticulata (L. & F.)	—	2	—	—	1	1	8	2	1				
Axinea subaustralis d'Orb	—	7	—	—	—	—	7	—	5	—	—	—	×
Gryphaeostrea vomer (Mort.)	—	—	—	—	2	—	7	1	—	1	6	—	×
Crassatellites subplanus (Con.)	—	—	—	—	2	1	7	1	4				
Cardium spillmani Con	—	2	—	—	—	—	7	—	—	—	—	—	×
Turritella vertebroides Mort	—	—	—	—	—	—	7	—	—	—	—	—	×
Lima pelagica Mort	—	—	—	—	—	—	6						
Liopistha protexta Con	—	—	—	—	—	1	6	3	1	—	—	—	×
Pyrifusus mullicaensis (Gabb)	—	—	—	—	—	—	6	—	1	—	—	—	×
Pyropsis trochiformis (Tuom.)	—	—	—	—	—	—	6	—	2	—	—	—	×
Volutomorpha conradi Gabb	1	—	—	—	—	—	6	—	—	—	—	—	×
Cithara mullicaensis Whitf	—	—	—	—	—	—	6						
Baculites ovatus Say	—	1	2	—	—	—	6	—	—	—	—	—	×

	Ripley Group.	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Inoceramus confertim-annulatus Roemer	—	—	—	—	—	—	5						
Veniella trigona Gabb	—	—	—	—	—	—	5	—	4	—	—	—	×
Trachytriton atlanticum Whitf	—	—	—	—	—	—	5						
Rostellites nasutus Gabb	—	1	—	—	—	—	5						
Ostrea falcata Mort	—	—	—	—	1	—	4	—	—	—	—	—	×
Pecten whitfieldi n. sp	—	—	—	—	—	—	4						
Paranomia scabra Mort	—	1	—	—	2	—	4	—	—	—	—	—	×
Lithophaga ripleyana (Gabb)	—	—	—	—	—	1	4						
Corimya tenuis Whitf	—	—	—	—	—	—	4						
Veniella conradi Mort	—	5	2	—	1	2	4	3	1	—	—	—	×
Gyrodes abyssima Mort	—	—	—	—	—	—	4	—	—	—	—	—	××
Xenophora leprosa Mort	—	—	—	—	—	—	4	—	—	—	—	—	×
Odontofusus typicus Whitf	—	—	—	—	—	—	4						
Turbinella alabamensis Gabb	—	—	—	—	—	2	4	—	—	—	—	—	×
Turbinella parva Gabb	—	—	—	—	—	—	4						
Callianassa mortoni Pilsb	—	1	—	—	—	—	4	—	4				
Arca uniopsis Con	—	—	—	—	—	—	3						
Pinna laqueata Con	—	2	1	—	—	—	3	—	—	—	—	—	××
Gervilliopsis ensiformis (Con.)	—	1	1	—	—	1	3	1	—	—	—	—	×
Pecten tenuitestus Gabb	—	—	—	—	—	—	3						
Neithea quinquecostata Lam	—	2	—	—	3	—	3						
Spondylus gregalis Mort	—	—	—	—	—	—	3						
Dianchora echinata (Mort.)	—	—	—	—	—	—	3	—	1				
Plagiostoma erecta (Whitf.)	—	—	—	—	3	—	3						
Anomia argentaria Mort	2	6	3	—	2	1	3	1	—	—	—	—	×
Legumen planulatum (Con.)	—	3	3	—	—	1	3	1	—	—	—	—	××
Leptosolen biplicata Con	1	3	1	—	—	2	3	3	—	—	—	—	××
Panopea decisa Con	—	4	2	—	—	1	3	1	—	—	—	—	×
Perissolax dubia (Gabb)	—	—	—	—	—	—	3						
Odontofusus medians Whitf	—	—	—	—	1	—	3	—	—	—	—	—	×
Piestochilus mucronatus Gabb	—	—	—	—	—	—	3						
Turbinopsis depressa Gabb	—	—	—	—	—	1	3						
Terebratella vanuxemi L. & F	—	—	—	—	—	—	2						
Nemodon eufaulensis Gabb	—	4	—	—	1	—	2	3	1	—	—	—	×
Cucullaea tippana Con	—	—	—	—	3	1	2	2	3	—	—	—	×
Pecten conradi Whitf	—	5	6	—	—	—	2						
Pecten argillensis Con	—	3	2	—	1	1	2	—	—	—	—	—	×
Plicatula urticosa Mort	—	—	—	—	—	—	2						
Mytilus smocki n. sp	—	—	—	—	—	—	2						
Unicardium umbonatum (Whitf.)	—	—	—	—	1	—	2						
Tenea parilis Con	1	2	5	—	—	2	2	2	1	—	—	—	×
Meretrix eufaulensis Con	—	—	—	—	1	1	2	—	—	—	—	—	×

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Pleurotomaria crotaloides (Mort.)	—	—	—	—	—	—	2	—	—	—	—	—	×
Anchura abrupta Con.	—	—	—	—	—	—	2	—	—	—	—	—	×
Triton precedens Whitf.	—	—	—	—	—	—	2						
Pyropsis retifer Gabb.	—	—	—	—	—	1	2						
Pyropsis septemlirata Gabb.	—	—	—	—	—	—	2						
Volutoderma ovata Whitf.	—	—	—	—	—	—	2						
Turbinopsis curta Whitf.	—	—	—	—	—	—	2						
Turbinopsis elevata Whitf.	—	—	—	—	—	—	2						
Actaeon cretacea Gabb.	—	—	—	—	—	1	2	1					
Cinulia naticoides Gabb.	—	—	—	—	—	—	2						
Haminea mortoni (Forbes)	—	—	—	—	—	—	2						
Nautilus dekayi Mort.	—	—	—	—	—	—	2	1	—	—	—	—	×
Paracyathus vaughani n. sp.	—	—	—	—	—	—	1						
Cardiaster smocki Clark n. sp.	—	—	—	—	—	—	1						
Meleagrinella abrupta (Con.)	—	—	—	—	—	—	1						
Ostrea nasuta Mort.	—	—	—	—	—	—	1	3	3	—	—	—	×
Ostrea monmouthensis n. sp.	—	—	—	—	—	—	1						
Trigonia thoracica Mort.	—	—	—	—	1	1	1	—	—	—	—	—	×
Pecten craticulus Mort.?	—	—	—	—	—	—	1						
Pecten quinquenaria Con.	—	—	—	—	—	1	1	—	—	—	—	—	×
Plicatula mullicaensis n. sp.	—	—	—	—	—	—	1						
Cuspidaria jerseyensis n. sp.	—	—	—	—	—	—	1	—	—	—	—	—	×
Caprotina jerseyensis n. sp.	—	—	—	—	—	—	1						
Cardium kümmeli n. sp.	—	—	—	—	—	—	1	1	4	—	—	—	×
Cardium trilineatum n. sp.	—	—	—	—	—	—	1						
Corbula crassiplica Gabb.	—	5	5	—	—	2	1	2	—	—	—	—	×
Gastrochaena whitfieldi n. sp.	—	—	—	—	—	—	1						
Scala sillmani Mort.	—	1	—	—	1	2	1	1	1	—	—	—	×
Lunatia ? pauperata (Whitf.)	—	—	—	—	—	—	1						
Rostellaria fusiformis Whitf.	—	—	—	—	—	—	1						
Rostellaria curta Whitf.?	—	—	—	—	—	—	1						
Cypraea mortoni Gabb.	—	—	—	—	—	—	1	—	—	—	—	—	×
Pyrifusus macfarlandi (Gabb)	—	—	—	—	—	—	1						
Pyropsis whitfieldi n. sp.	—	—	—	—	—	—	1						
Pyropsis richardsoni (Tuom.)	—	1	—	—	—	—	1	—	—	—	—	—	×
Serrifusus crosswickensis Whitf.	—	—	—	—	—	—	1						
Volutomorpha gabbi Whitf.	—	—	—	—	—	—	1						
Volutomorpha ponderosa Whitf.	—	—	—	—	—	—	1						
Piestochilus bella (Gabb)	—	—	—	—	—	—	1						
Rostellites angulatus Whitf.	—	—	—	—	—	—	1						
Morea plicata (Whitf.)?	—	—	—	—	—	—	1						
Cylichna recta Gabb.	—	—	—	—	—	1	1						
Heteroceras conradi Mort.	—	—	—	—	—	—	1						

ANALYTICAL DISCUSSION OF THE MOUNT LAUREL-NAVESINK FAUNA.

The following summary presents the data recorded in the above table in a condensed form, showing the number of species common to the Mount Laurel-Navesink and to each of the other formations in the series. Fifty-four of the total 112 species in the fauna, or 48 per cent., have not been recognized in any other horizon:

Cliffwood,	4
Merchantville,	28
Woodbury,	14
Marshalltown,	20
Wenonah,	26
MT. LAUREL-NAVESINK,	112
Red Bank,	23
Tinton,	22
Ripley Group, etc.,	48

A careful analysis of the Mount Laurel-Navesink fauna shows several peculiar characteristics in which it differs from any of the other faunas of the series. In the first place the number of recognized species is larger than in any of the other faunas, a fact which might be due to the larger number of localities from which collections have been examined. However, from many of the localities recorded, it was quite impossible to make complete collections, and only a few of the common species, such as could be gathered in a few minutes' search, were secured, and while the larger number of localities may account in part for the larger fauna, it cannot wholly do so, and it is certainly true that this horizon actually does contain a larger fauna than any of the others.

In the second place this fauna contains a much larger proportion (48%) of species which are restricted to it than does any other in the series, as may be seen in the following table showing the percentages of restricted species in each fauna.

Formation.	*Restricted.*	*Extraterritorial.*
Cliffwood,	40%	49%
Merchantville,	32%	42%
Woodbury,	33%	45%
Marshalltown,	23%	60%
Wenonah,	23%	62%
Mt. Laurel-Navesink,	48%	42%
Red Bank,	9%	69%
Tinton,	21%	60%

Accompanying this larger percentage of species which are restricted to this fauna in New Jersey, the above table shows further that there is a decided reduction in the percentage of species which are extra-territorial in their distribution, or in those which occur also in the Ripley faunas of the Gulf border region, only 42 per cent. being recognized. These two facts, when taken together, suggest that there was an immigration of species into the region from some other direction than the south.

A third peculiarity of this fauna is the large number of gastropods present, as compared with the other faunas in the series, a fact which is shown clearly in the following table recording the number of species of Pelecypods and Gastropods in the several faunas.

	Pelecypoda.	*Gastropoda.*
Cliffwood,	33	8
Merchantville,	62	29
Woodbury,	65	23
Marshalltown,	35	6
Wenonah,	59	17
Mt. Laurel-Navesink,	56	46
Red Bank,	38	4
Tinton,	25	5

It is seen from this that in the Mount Laurel-Navesink fauna a nearly equal number of Pelecypods and Gastropods are present, while the Gastropods do not exceed 50 per cent. of the Pelecypods in any other fauna of the series.[1] In the Red Bank and Tinton

[1] If the undetermined species were included in this estimate the total number of gastropod species would more than equal the number of pelecypods. Also, if these undetermined forms were included the percentage of restricted species would be materially increased, and the percentage of extraterritorial one reduced.

formations the actual number of Gastropods should be greater than the table indicates, because of several undetermined forms, but if all these species were included the proportion would not nearly reach that shown by the Navesink fauna.

The two species occurring in the Mount Laurel-Navesink fauna, which may be taken as the most characteristic members of the fauna, are *Belemnitella americana* and *Terebratella plicata*. Neither of these occur in any of the other faunas of the series. The first of them has been detected in 19 of the 22 localities which are recorded, and with a little search the species would, doubtless, be found also in the other three. The second species has been recognized in only 15 of the localities, but this, too, would, doubtless, be found in most of the others were complete collections available. These two species are totally different from any of the forms which have preceded them in the region. They could not have been derived through the processes of evolution from any members of preceding faunas in New Jersey, and must be considered as representatives of an immigrant element in the fauna. *Belemnitella americana* occurs at widely distributed localities in the southern States, but it is always a rare form, while in New Jersey it is usually common and is frequently abundant. *Terebratella plicata*, however, has not been recorded from any of the localities of the Gulf-border region. The relationships of *B. americana* are more close with the European *B. mucronata* than with any other species; in fact, it is doubtful whether the two should be considered as specifically distinct. In England and France this species is highly characteristic of a horizon near the summit of the Senonian. *Terebratella plicata* does not have so close an ally in the European faunas, its closest relationship evidently being with *T. menardi* Lam. of England and France. In Europe this brachiopod occurs in the Upper Greensand, a horizon considerably lower in the Upper Cretaceous than the *Belemnitella mucronata* zone. Still, the occurrence in European faunas of a brachiopod so similar in form to this American shell, and the entire absence of any related forms in other portions of America, as well as the close relationship or identity of the species of *Belemnitella*, strongly suggests a European origin for this conspicuous immigrant element in the *Belemnitella* fauna of the

Mt. Laurel-Navesink formations in New Jersey. It is not necessary to assume that this faunal element in New Jersey immigrated directly from the regions in Europe where the *Belemnitella mucronata* zone is known to occur, since the facts may be interpreted to mean that this *Belemnitella* fauna has migrated from some unknown province into both the regions where it is now known to occur so conspicuously, in America and in Europe.

If the assumption is correct that the *Belemnitella* element of Mount Laurel-Navesink fauna was an immigrant from the east, possibly from Europe, it is strange that it did not spread down the Atlantic coast and occupy a conspicuous place in the faunas of the Gulf-border region. It is true that the *Belemnitella* does occur rarely in the south, although it is never a conspicuous member of the faunas, but *Terebratella plicata* is not known to occur in that region at all. It is possible that the explanation of the rarity of this element in the faunas of the South may be due to the debouchure of a great Cretaceous river near the present position of the Delaware or Chesapeake bays. A great stream of fresh water might, under certain conditions, be a more or less efficient barrier to the coastwise migration of certain forms of shallow water life. To the squid-like Belemnites, however, such a barrier would doubtless be less effective than to the brachiopods. This explanation of the distribution of the faunas is offered only as a suggestion, since it is difficult to understand why such a barrier should not have been just as effective against the spread of certain conspicuous forms in the fauna which are evidently of southern origin, as against organisms migrating in the opposite direction, although the southern forms, so far as they are recognized, are pelecypods and gastropods, while *Terebratella plicata,* the one form which most clearly suggests a barrier of some sort, is a brachiopod, a very different type of organism.

Aside from this foreign element in the Mount Laurel-Navesink fauna, we find recurring here the conspicuous *Exogyra* element which had first appeared in New Jersey in the Marshalltown fauna, although *E. ponderosa* of the earlier fauna has given place here to *E. costata.* This species differs from the *Belemnitella* and *Terebratella,* in being a conspicuous member of the Upper

Cretaceous faunas of the Gulf-border region in America, where it is more abundant, apparently, than in New Jersey. It may be safely assumed that this species and some of its associates originated in this southern region in America and spread northward to New Jersey, probably continuing eastward to where it is found in the European faunas. The *Gryphaea convexa* is perhaps not distinct from the abundant European *G. vesicularis* Lam., and the same or closely allied forms occur commonly in the faunas of the Gulf border region. It may have originated in the New Jersey faunas from Europe or the east, although its appearance in New Jersey in the Marshalltown associated with the southern *Exogyra ponderosa,* before the appearance in the region of the more clearly European *Belemnitella,* suggests that its origin also was from the south.

With the incomplete knowledge which we must necessarily possess of most fossil faunas, it is difficult to analyze them exactly into their component elements. Undoubtedly a considerable number of other species accompanied *Belemnitella* and *Terebratella* in their migration from the east, and it may be assumed that all the species characteristic of this fauna alone in New Jersey and not known to occur elsewhere in America belong to this class. Further faunal studies, however, especially in the Gulf-border region may change the status of many of these species, and it is not improbable that some molluscs which accompanied *Belemnitella* from the east spread into the southern region, just as *Belemnitella* itself is known to have done.

A third conspicuous element in the Mount Laurel-Navesink fauna, distinct from the European *Belemnitella* and its associates, and also from the southern *Exogyra* element, is the *Cucullaea* fauna recurrent from the Merchantville and the Marshalltown. The largest number of Mount Laurel-Navesink species common to any other fauna of this New Jersey series, is found in the Merchantville, and among these species are to be found such highly characteristic forms as *Axinea subaustralis* and *Cucullaea antrosa,* with an entire absence of the characteristic members of the *Lucina cretacea* fauna of the Woodbury clay.

The most characteristic species of the foreign immigration

element of the Mount Laurel-Navesink fauna, *Belemnitella americana* and *Terebratella plicata,* are restricted absolutely to this horizon in New Jersey, and the zone through which they occur undoubtedly represents a strict zone of contemporaneity through the Cretaceous sediments of the State. This contemporaneous life zone, however, does not conform strictly with the stratigraphic relations of the sediments, since the *Belemnitella* fauna occurs in both the Mount Laurel sand and the Navesink marl. The stratigraphic line between these two formations cuts diagonally across the life zone from near its lower limit in the northeast to its summit in the southwest. The fauna of this life zone, in its entirety, is a composite assemblage of life having at least three distinct elements: (1) the indigenous, shifting, *Cucullaea* element recurrent from the Merchantville and the Marshalltown; (2) the southern *Exogyra* element, recurrent from the Marshalltown, and (3) the foreign *Belemnitella* element, probably an immigrant from Europe.

CHAPTER X.

THE RED BANK SAND.

The Red Bank sand, the "red sand" of Cook, has its most characteristic development in eastern Monmouth County. In the lower beds of the formation there is a gradual transition from the subjacent Navesink marl, from 10 to 20 feet of the lower beds being dark-colored sandy clays, with more or less glauconite. The great mass of the formation, at least in the weathered condition in which it is usually seen, is composed of a highly characteristic, very ferruginous red sand. The total thickness of the formation in eastern Monmouth County is nearly 100 feet.

Towards the southwest the Red Bank sand becomes much less characteristic, the bed being reduced in thickness, until beyond the western border of Monmouth County the formation cannot be differentiated. It has already been shown how the Navesink marl of eastern Monmouth County is displaced in its southward extension by the greater and greater development of the subjacent Mount Laurel sand. It is undoubtedly true that the *Belemnitella* fauna of the Mount Laurel-Navesink represents a contemporaneous life zone, and consequently the boundary line between the Mount Laurel and Navesink is not a contemporaneous line, but in passing from the northeast to the southwest represents a later and later time until finally the sand deposition continues through the entire period of deposition of the Navesink marl of eastern Monmouth County, and the greensand deposition becomes contemporaneous with the typical Red Bank sand of the more northeastern area, and continues without interruption into the Hornerstown marl formation. The disappearance of the Red Bank sand to the southwest, therefore, does not represent any lack of continuity of sedimentation, nor an overlap unconformity, but simply a change in the nature and thickness of the sediments in passing along the strike of the beds.

FAUNA OF THE RED BANK SAND.

The fauna of the Red Bank sand is known chiefly from the lower, black, clayey layers of the formation. These beds contain an assemblage of species quite different in character from the Mount Laurel-Navesink fauna, being in the main a recurrence of the faunas from the formations below the Mount Laurel. Fossils are scarce and poorly preserved in the typical, upper, red-sand division of the formation, and have rarely been observed. The four localities which have afforded fossils during the recent operations of the Survey, are all at no great distance from the town of Red Bank, and the three showing the best representation of the fauna are all from the lower, black, sandy-clay division of the formation.

Locality 119.—The Red Bank sand is well exposed upon both shores of the Shrewsbury River in the vicinity of Red Bank, the beds for the most part being a black, clayey sand, with more or less glauconite. The locality under consideration here is upon the north shore of the river, just east of Guyon's Point, about 2 miles from the railroad station at Red Bank. The following species have been identified in the fauna from this place:

PELECYPODA.

Nucula whitfield n. sp.
Perrisonota protexta Con.
Nemodon eufaulensis (Gabb).
Cucullaea tippana Con.?
Ostrea plumosa Mort.?
Ostrea mesenterica Mort.
Gryphaea convexa Mort.
Exogyra costata Say.
Trigonia kümmeli n. sp.
Pecten venustus Mort.
Lima reticulata (L. & F.).
Liopistha protexta Con.
Cuspidaria ventricosa M. & H.
Veniella conradi Mort.

Tenea parilis Con.
Peronaeoderma georgiana (Gabb).
Leptosolen biplicata Con.
Cymbophora lintea (Con.).

GASTROPODA.

Pyropsis sp.
Actaeon cretacea Gabb.

Locality 116.—On the south bank of the Shrewsbury River, about one mile from the railroad station at Red Bank, the black, clayey, Red Bank sand has yielded the following fauna. The specimens are, for the most part, poorly preserved casts, and besides the species recorded there are a number of others, especially gastropods, which are represented by specimens too poorly preserved to admit of identification:

PELECYPODA.

Perrisonota protexta Con.
Nemodon eufaulensis (Gabb).
Cucullaea tippana Con.
Gervilliopsis ensiformis (Con.).
Ostrea mesenterica Mort.
Ostrea nasuta Mort.
Gryphaea sp.
Trigonia kümmeli n. sp.
Pecten venustus Mort.
Crenella serica Con.
Liopistha protexta Con.
Cuspidaria ventricosa M. & H.
Veniella conradi Mort.
Crassatellites subplanus (Con.).
Lucina cretacea Whitf.
Tenea parilis Con.
Linearia metastriata Con.
Leptosolen biplicata Con.
Leptosolen ? elongata n. sp.

Solyma lineolata Con.
Cymbophora lintea (Con.).
Corbula crassiplica Gabb.
Panopea decisa Con.

GASTROPODA.

Scala sillmani (Mort.).
Gyrodes petrosus Mort.

CEPHALOPODA.

Nautilus dekayi Mort.

Locality 123.—On the south side of Tower Hill, in the eastern part of the town of Red Bank, a coarse, red, incoherent, quartz sand, belonging in the Red Bank formation, is exposed. The fossils are poorly preserved but the following species have been recognized:

PELECYPODA.

Ostrea nasuta Mort.
Gryphaea sp.
Gryphaeostrea vomer (Mort.).
Pecten venustus Mort.
Lima reticulata (L. & F.).

Locality 112.—In the bank of a small brook at a road corner 2.5 miles southwest of Middletown, a black, clayey sand of the Red Bank formation, similar lithologically to the beds along the Shrewsbury River at Red Bank, has yielded the following fauna:

PELECYPODA.

Nucula whitfieldi n. sp.
Perrisonota protexta Con.
Nemodon eufaulensis (Gabb).
Nemoarca cretacea Con.
Axinea compressa n. sp.
Pteria navicula Whitf.
Ostrea nasuta Mort.

Trigonia kümmeli n. sp.
Pecten simplicum Con.
Anomia argentaria Mort.
Crenella serica Con.
Liopistha protexta Con.
Cuspidaria ventricosa M. & H.
Veniella conradi Mort.
Lucina cretacea Whitf.
Cardium dumosum Con.
Cardium kümmeli n. sp.
Cardium wenonah n. sp.
Legumen planulatum (Con.).
Tellinimera eborea (Con.).
Leptosolen biplicata Con.
Leptosolen ? elongata n. sp.
Cymbophora lintea (Con.).
Corbula crassiplica Gabb.
Corbula sp.

GASTROPODA.

Gyrodes petrosus Mort.
Turritella sp.
Bulla macrostoma Gabb.

TABLE OF DISTRIBUTION FOR THE RED BANK FAUNA.

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Perrisonota protexta Con.	—	3	2	—	—	1	—	3	1				
Nemodon eufaulensis (Gabb)	—	4	—	—	1	—	2	3	1	—	—	—	XX
Ostrea nasuta Mort.	—	—	—	—	—	—	1	3	3	—	—	—	X
Trigonia kümmeli n. sp.	—	—	—	—	—	—	—	3					
Pecten venustus Mort.	—	—	—	—	1	—	8	3	3				
Liopistha protexta Con.	—	—	—	—	—	1	6	3	1	—	—	—	XXX
Cuspidaria ventricosa M. & H.	—	—	—	—	—	1	—	3	1	—	—	—	
Veniella conradi Mort.	—	5	2	—	1	2	4	3	1	—	—	—	XXX
Leptosolen biplicata Con.	1	3	1	—	—	2	3	3	—	—	—	—	XXX
Cymbophora lintea (Con.)	5	3	4	—	1	2	—	3	1	—	—	—	X
Nucula whitfieldi n. sp.	1	3	4	—	—	2	—	2					
Cucullaea tippana Con.	—	—	—	—	3	1	2	2	3	—	—	—	X
Ostrea mesenterica Mort.	—	—	—	—	—	—	14	2	2				
Lima reticulata (L. & F.)	—	2	—	—	1	1	8	2	1				
Crenella serica Con.	—	—	—	—	1	—	—	2	—	—	—	—	
Lucina cretacea Whitf.	2	—	6	—	—	—	—	2	—	—	—	—	XXX
Tenea parilis Con.	1	2	5	—	—	2	2	2	1	—	—	—	XXX
Leptosolen ? elongata n. sp.	—	—	—	—	—	—	—	2					
Corbula crassiplica Gabb.	—	5	5	—	—	2	1	2	—	—	—	—	XX
Gyrodes petrosus Mort.	—	2	—	—	—	2	10	2	—	—	—	—	XX
Nemoarca cretacea Con.	—	4	5	—	—	1	—	1					
Axinea compressa n. sp.	—	—	—	—	—	—	—	1					
Gervilliopsis ensiformis (Con.)	—	1	1	—	—	1	3	1	—	—	—	—	X
Pteria navicula Whitf.	—	—	1	—	—	—	—	1					
Ostrea plumosa Mort.?	—	—	—	—	1	—	—	1	—	—			
Gryphaeostrea vomer (Mort.)	—	—	—	—	2	—	7	1	—	1	6	—	XXX
Exogyra costata Say.	—	—	—	—	—	—	18	1	2	—	—	—	XXX
Pecten simplicum Con.	—	—	—	—	—	—	—	1	3				
Anomia argentaria Mort.	2	6	3	—	2	1	3	1	—	—	—	—	X
Crassatellites subplanus (Con.)	—	—	—	—	2	1	7	1	4				
Cardium dumosum Con.	—	—	3	—	—	1	—	1					
Cardium kümmeli n. sp.	—	—	—	—	—	—	1	1	4	—	—	—	XXX
Cardium wenonah n. sp.	—	—	—	—	—	1	—	1	—	—	—	—	
Legumen planulatum (Con.)	—	3	3	—	—	1	3	1	—	—	—	—	XXX
Peronaeoderma georgiana (Gabb)	—	—	1	—	—	1	—	1	—	—	—	—	XXX
Linearia metastriata Con.	1	3	2	—	1	1	—	1	—	—	—	—	XXX
Tellinimera eborea Con.	—	3	1	—	—	2	—	1	—	—	—	—	XXX
Solyma lineolata Con.	1	3	3	—	—	1	—	1	—	—	—	—	XXX
Panopea decisa Con.	—	4	2	—	—	1	3	1	—	—	—	—	XXX
Scala sillmani (Mort.)	—	1	—	—	1	2	1	1	1	—	—	—	X
Actaeon cretacea Gabb.	—	—	—	—	—	1	2	1					
Bulla macrostoma Gabb.	—	—	—	—	—	—	—	1	—	—	—	—	XX
Nautilus dekayi Mort.	—	—	—	—	—	—	2	1	—	—	—	—	XX

ANALYTICAL DISCUSSION OF THE RED BANK FAUNA.

A summary of the above tables shows the following numbers of Red Bank species which are common to each of the other faunas in the series. Only 4 species, or 9 per cent. of the whole, are restricted to the Red Bank.

Cliffwood,	8
Merchantville,	19
Woodbury,	19
Marshalltown,	13
Wenonah,	27
Mt. Laurel-Navesink,	23
RED BANK,	43
Tinton,	17
Ripley Group, etc.,	29

In its essential features the Red Bank fauna is a recurrence of the *Lucina cretacea* fauna of the Cliffwood, Woodbury and Wenonah formations, with a smaller element holding over from the Navesink. None of the highly characteristic species of the foreign element in the Navesink fauna, however, such as *Belemnitella americana* and *Terebratella plicata* occur in the Red Bank. A notable feature of the Red Bank fauna is the small number of species which are restricted to it, these species constituting only 9 per cent., while in the Mount Laurel-Navesink 48 per cent. of the species were restricted to the fauna. The essentially recurrent nature of the fauna and its relationships to the Wenonah and Woodbury, rather than to the Mount Laurel-Navesink and Marshalltown faunas, is clearly shown by the table above, the Wenonah and Woodbury faunas having more species common to the Red Bank than do the Mount Laurel-Navesink and Marshalltown. The Merchantville has the same number of Red Bank species as are present in the Woodbury, 15 of the 19 such species being present also in the Woodbury. The reappearance in the Red Bank fauna of *Lucina cretacea* is an important feature in the fauna. This species was one of the most diagnostic members of the Woodbury fauna, but has not been observed in any

of the intervening beds, although it is rather a common species at two of the Red Bank localities. Other Woodbury species in the fauna which have not been observed elsewhere, unless in the Wenonah, are *Pteria navicula, Cardium dumosum* and *Peronaeoderma georgiana.*

Such forms as *Ostrea mesenterica, Ostrea nasuta, Gryphaeostrea vomer, Exogyra costata, Pecten venustus,* and *Crassatellites subplanus,* are persistent Navesink forms which continue in the Red Bank, and the species of *Gryphaea* which is not infrequently met with is in the same category. Although this *Gryphaea* is somewhat common in the fauna, not sufficiently complete examples have been observed to admit of their accurate identification, although they seem to be at least varietially different from the common Navesink form *G. convexa.*

CHAPTER XI.

THE TINTON BEDS.

In his discussion of the "red sand," Cook recognized an upper division which he designated as the "indurated green earth,"[1] and Clark followed Cook in including this bed in the Red Bank sand. These beds, however, are somewhat different from the subjacent sand beds, especially in the much larger content of glauconite and in the induration of the sediments. In the deep cut at Beers Hill, on the Keyport and Holmdel turnpike, the entire thickness of this formation is exposed, about 12 feet in all, the basal portion of the formation being locally a nearly pure greensand marl. At Tinton Falls, where this formation is 22 feet in thickness, the indurated sediments are responsible for a waterfall in a tributary of the Swimming River. Not only are these indurated beds lithologically distinct from the Red Bank sand, but the fauna also is quite different, it consisting largely of a recurrent Navesink element. Because of this faunal and lithologic differentiation of the bed it has seemed advisable to distinguish it by a special name, and the name Tinton beds has been proposed[2] and will be used here.

In its geographic distribution the Tinton formation cannot be differentiated beyond the point where the Red Bank sand is typically developed, the most southwestern locality observed where the bed can be certainly recognized being at Red Valley. In eastern Monmouth County the formation can always be recognized in its proper position in the section, unless it is too deeply covered with superficial deposits.

[1] Geol. N. J., 1868, p. 268.

[2] Jour. Geol., vol. 13, p. 81; also, Geol. Surv. N. J., Am. Rep. State Geol., for 1904, p. 155.

FAUNA OF THE TINTON BEDS.

The most complete fauna of the Tinton beds has been collected from the exposures in the deep cut at Beers' Hill, where fossils have been secured from several distinct beds. The assemblage of species in the different beds is somewhat different, and in the number of localities recognized each of these beds is considered separately. The various localities from which fossils have been studied, with the several local faunas, are as follows:

Locality 110.—From the typical exposure of the Tinton beds, just below the mill at the village of Tinton Falls, the following species of fossils have been identified:

PELECYPODA.

Cucullaea sp.
Axinea subaustralis d'Orb.
Ostrea mesenterica Mort.
Gryphaea sp.
Pecten venustus Mort.
Pecten simplicum Con.
Dianchora echinata Mort.
Cardium sp.

GASTROPODA.

Margarita abyssima (Gabb).
Pyropsis trochiformis (Tuom.).

CEPHALOPODA.

Sphenodiscus lobatus (Tuom.).

CRUSTACEA.

Callianassa mortoni Pilsb.
Callianassa conradi Pilsb.

One of the best exposures of the Tinton beds, and the locality which has furnished the most abundant fauna, is in the deep

cut at Beers Hills, on the Keyport and Holmdel turnpike (Locality 129). The section at this locality, as made out by the writer, is as follows, beginning at the base:

Red Bank Sand.

129[1]. Dark sand, often black in color, and sometimes much iron-stained, scarcely consolidated. Traces of fossils are present, but they are not abundant and are too poorly preserved to be readily identified, ... ±20 feet.

129[2]. Yellow or red sand, sometimes becoming black above, ... 2½ feet.

129[3]. Brown, iron-stained, more or less indurated sand, ... 2-3 feet.

129[4]. Extremely variable yellow or gray sand, ... 3 feet.

Tinton Beds.

129[5]. Dark, brown or yellowish sand, more or less glauconitic, sometimes almost pure green-sand; sometimes indurated. Fossils abundant, ... 3 feet.

129[6]. Ferruginous sand of variable character, the bed not strictly horizontal in position, ... ±½ foot.

129[7]. Indurated, sandy greensand marl, with many fossils, one species of *Cucullaea* being the most conspicuous form, ... 3 feet.

129[8]. Indurated, sandy, greensand marl, similar to the subjacent bed but with the fossils of that bed rare or absent. The bed is crowded with peculiar, more or less cylindrical, vertical bodies, probably burrows of some sort or vegetable in origin, having a maximum length of about 1 foot, with a diameter varying from ½ to ¾ of an inch, ... 4 feet.

129[9]. Rock similar to that below, but with an abundance of fossils, the shells of which in the unweathered portion of the bed have been replaced by a blue or greenish mineral, *vivianite*, ... 2 feet.

Hornerstown Marl.

129[10]. Greensand marl with thin bands, more or less indurated with iron, extending to the top of the bank, . . ± 10 feet.

Locality 129[5].—This bed has yielded the following fauna:

ECHINODERMATA.
Catopygus sp.

PELECYPODA.
Leda tintonensis n. sp.
Perissonota protexta Con.
Axinea subaustralis d'Orb.
Exogyra costata Say.
Trigonia cerulea Whitf.
Pecten venustus Mort.
Pecten simplicum Con.
Crenella elegantula M. & H.
Liopistha protexta Con.
Cuspidaria ventricosa M. & H.
Veniella conradi Mort.
Veniella trigona Gabb.
Crassatellites subplanus (Con.).
Tenea paralis Con.
Cardium kümmeli n. sp.
Isocardia tintonensis n. sp.
Cymbophora lintea (Con.).

Locality 129[7].—In addition to the following list of species from this bed, several gastropods were collected which it has been impossible to identify because of their poor state of preservation:

PELECYPODA.
Cucullaea tippana Con.
Cucullaea littlei Gabb.
Axinea subaustralis d'Orb.

Trigonia cerulia Whitf.
Veniella trigona Gabb.
Crassatellites subplanus (Con.).
Cardium kümmeli n. sp.

GASTROPODA.
Several undetermined species.

CEPHALOPODA.
Sphenodiscus lobatus (Tuom.).

CRUSTACEA.
Callianassa mortoni Pilsb.

Locality 129[9].—This bed has yielded the following fauna:

BRACHIOPODA.
Lingula sp.

PELECYPODA.
Nemodon eufaulensis Gabb.
Cucullaea tippana Con.
Axinea subaustralis d'Orb.
Ostrea nasuta Mort.
Gryphaea sp.
Exogyra costata Say.
Trigonia cerulia Whitf.
Veniella trigona Gabb.
Crassatellites subplanus (Con.).
Cardium kümmeli n. sp.
Cardium sp.
Meretrix ? sp.

GASTROPODA.
Pyropsis trochiformis (Tuom.).
Several undermined species.

CRUSTACEA.

Callianassa mortoni Pilsb.
Callianassa conradi Pilsb.

Locality 132.—In the bank of a run at the south side of Chas. Campbell's farm, 4.5 miles east of Freehold, and 1.5 miles southwest of Colts Neck, the following species have been collected from the Tinton beds:

PELECYPODA.

Cucullaea tippana Con.
Cucullaea antrosa Mort.
Axinea subaustralis (d'Orb.).
Ostrea mesenterica Mort.
Ostrea nasuta Mort.
Gryphaea sp.
Trigonia cerulia Whitf.
Pecten venustus Mort.
Pecten simplicum Con.
Lima reticulata (L. & F.)
Veniella trigona Gabb.
Crassatellites subplanus (Con.).
Cardium kümmeli n. sp.

GASTROPODA.

Scala sillmani (Mort.)
Anchura pennata Mort.
Pyrifusus mullicaensis Gabb.

CEPHALOPODA.

Sphenodiscus lobatus (Tuom.).

CRUSTACEA.

Callianassa mortoni Pilsb.

Locality 123.—In the bank of Ivanhoe Brook, about 1 mile east of Red Valley, *Ostrea nasuta* is not uncommon in a coarse sand which is probably to be included in the Tinton, although

it is possibly in the Red Bank formation. Because of the isolated nature of the outcrop it is not possible to certainly establish its stratigraphic relations.

Locality 152.—At the road side just east of the mill at Red Valley, is an outcrop which represents the most southwesterly extension of what can be definitely distinguished as the Tinton beds. Fossils are not abundant, and only the following species have been recognized:

PELECYPODA.

Ostrea nasuta Mort.
Pecten simplicum Con.

CRUSTACEA.

Callianassa sp.

TABLE OF DISTRIBUTION FOR THE TINTON FAUNA.

	Cliffwood (5).	Merchantville (8).	Woodbury (6).	Englishtown.	Marshalltown (4).	Wenonah (2).	Mt. Laurel-Navesink (22).	Red Bank (4).	Tinton (6).	Hornerstown.	Vincentown.	Manasquan.	Ripley Group, etc.
Axinea subaustralis d'Orb.	—	7	—	—	—	—	7	—	5	—	—	—	×
Trigonia cerulia Whitf.	—	—	—	—	—	—	—	—	4				
Veniella trigona Gabb.	—	—	—	—	—	—	5	—	4	—	—	—	×
Crassatellites subplanus (Con.)	—	—	—	—	2	1	7	1	4				
Cardium kümmeli n. sp.	—	—	—	—	—	—	1	1	4	—	—	—	×
Callianassa mortoni Pilsb.	—	1	—	—	—	—	4	—	4				
Cucullaea tippana Con.	—	—	—	—	3	1	2	2	3	—	—	—	×
Ostrea nasuta Mort.	—	—	—	—	—	—	1	3	3	—	—	—	×
Gryphaea sp.	—	—	—	—	—	—	—	—	3				
Pecten venustus Mort.	—	—	—	—	1	—	8	3	3				
Pecten simplicum Con.	—	—	—	—	—	—	—	1	3				
Sphenodiscus lobatus (Tuom.)	—	—	—	—	—	—	—	—	3	—	—	—	×
Ostrea mesenterica Mort.	—	—	—	—	—	—	14	2	2				
Exogyra costata Say.	—	—	—	—	—	—	18	1	2	—	—	—	×
Pyropsis trochiformis (Tuom.)	—	—	—	—	—	—	6	—	2	—	—	—	×
Leda tintonensis n. sp.	—	—	—	—	—	—	—	—	1				
Perissonota protexta Con.	—	3	2	—	—	1	—	3	1				
Nemodon eufaulensis Gabb.	—	4	—	—	1	—	2	3	1	—	—	—	×
Cucullaea antrosa Mort.	—	4	1	—	—	—	10	—	1				
Cucullaea littlei Gabb.	—	—	—	—	—	—	—	—	1	—	—	—	×
Dianchora echinata Mort.	—	—	—	—	—	—	3	—	1				
Lima reticulata (L. & F.)	—	2	—	—	1	1	8	2	1				
Crenella elegantula M. & H.	—	—	—	—	—	—	—	—	1	—	—		
Liopistha protexta Con.	—	—	—	—	—	1	6	3	1	—	—	—	×
Cuspidaria ventricosa M. & H.	—	—	—	—	—	1	—	3	1	—	—	—	×
Veniella conradi Mort.	—	5	2	—	1	2	4	3	1	—	—	—	×
Tenea parilis Con.	1	2	5	—	—	2	2	2	1	—	—	—	×
Isocardia tintonensis n. sp.	—	—	—	—	—	—	—	—	1				
Cymbophora lintea (Con.)	5	3	4	—	1	2	—	3	1	—	—	—	×
Margarita abyssima (Gabb)	—	1	1	—	—	—	9	—	1				
Scala sillmani (Mort.)	—	1	—	—	1	2	1	1	1	—	—	—	×
Anchura pennata Mort.	—	—	—	—	—	—	15	—	1	—	—	—	×
Pyrifusus mullicaensis Gabb.	—	—	—	—	—	—	6	—	1	—	—	—	×
Callianassa conradi Pilsb.	—	—	—	—	—	—	—	—	1				

Analytical Discussion of the Tinton Fauna.

The summary table here given exhibits some of the data recorded in the above distribution tables in a condensed form, 7 of the species, or 21 per cent. of the whole, being restricted to the formation:

Cliffwood,	2
Merchantville,	11
Woodbury,	6
Marshalltown,	8
Wenonah,	10
Mt. Laurel-Navesink,	22
Red Bank,	17
TINTON,	33
Ripley Group, etc.,	20

A notable feature of the above summary table is the distinct alternation which is shown in the relationships of the Tinton fauna, as exhibited by the number of species common to the Tinton and to each of the other faunas in succession, the Navesink, Marshalltown and Merchantville being the more closely allied to the Tinton. The only exception in this regular sequence of alternation is in the Wenonah, where a larger number of Tinton species are present than in the Marshalltown. It has already been shown, however, that the Wenonah fauna is distinctly different from that of the Marshalltown and the Mount Laurel-Navesink, having its most intimate relations with the Woodbury. The greatest community of species is between the Tinton and the Mount Laurel-Navesink faunas, two-thirds of the Tinton species being present in this earlier fauna. The following Tinton species, not observed in the Red Bank, are recurrent from the Mount Laurel-Navesink:

Cucullaea antrosa.
Axinea subaustralis.
Dianchora echinata.
Veniella trigona.
Margarita abyssima.

Anchura pennata.
Pyrifusus mullicaensis.
Pyropsis trochiformis.
Callianassa mortoni.

Among the conspicuous members of the Tinton fauna are the crustacean claws belonging to the genus *Callianassa.* Examples of these claws can usually be found at exposures of the formation, even though the outcrop is highly weathered. In the Mount Laurel-Navesink faunas the same form of claws are usually present in the more southwestern localities, although they have not been commonly observed in Monmouth County.

Only a small proportion of the members of the Tinton fauna are restricted to the formation, 21 per cent. in all, but among these species is *Sphenodiscus lobatus,* an ammonite distinctly different from any which have been present in preceding faunas, but which is so widely distributed in the Tinton beds that it may be taken as one of the most characteristic members of the fauna.

CHAPTER XII.

THE HORNERSTOWN MARL.

Clark proposed the name Sewell for the old "middle marl" formation of Cook, omitting the limesand portion, but since this term was previously applied to a formation in the Carboniferous of Virginia and West Virginia, the name "Hornerstown," first applied by Knapp in unpublished manuscript, is used instead. The formation can be traced across the State from Monmouth to Salem counties, and is uniformly a dark, nearly pure, greensand marl, although the glauconite content diminishes somewhat in its southwestward extension. In Monmouth County the total thickness of the formation is about 30 feet, and it is sharply differentiated from the Tinton beds below and from the Vincentown formation above. Further south, however, where the Red Bank and Tinton formations are no longer typically developed, their time interval being occupied by the more highly glauconitic beds which seem to be the southern continuation of the Navesink marl of the north, it becomes impossible to recognize any definite base for the Hornerstown marl.

FAUNA OF THE HORNERSTOWN MARL.

The main portion of the Hornerstown marl is only sparsely fossiliferous, but at the very summit of the formation a distinct shell layer 5 feet or less in thickness is uniformly present, composed of vast numbers of a species of *Gryphaea* and usually with very many examples of *Terebratula harlani*. Collections have been made from the formation from the following localities:

Locality 152.—This locality is ¾ mile southwest of Hornerstown, and lies southwest of that point in the State where the Tinton beds can be differentiated as a distinct formation, and as

the southwestern extension of the Red Bank sand assumes a more and more marly character, becoming a nearly pure greensand marl opposite Hornerstown, it is not possible to draw a line to separate this marl from the subjacent formation in this region. The fossils in the following list were collected from beds along the creek just below the extensive marl pits which were formerly operated near Hornerstown, and are from strata which lie beneath the beds which have been excavated. The same fossils, however, are highly characteristic of the Hornerstown marl in J. S. Cook's pits near Tinton Falls, where the marl bed is distinctly above the Tinton beds, and consequently the fossil-bearing beds near Hornerstown are included in the Hornerstown formation. The known fauna consists of only three recognized forms, as follows:

PELECYPODA.

Cucullaea vulgaris Mort.
Cucullaea compressirostra Whitf.

GASTROPODA.

Turritella sp.

Locality 142.—On Crosswicks Creek, about 1 mile north of New Egypt, the Hornerstown marl has been extensively dug in the marl pits of George Hartshorn. Several layers may be distinguished at this point, as follows:

142[1]. The lower portion of the Hornerstown formation at this locality is a pure greensand marl, which has been excavated to a depth of 10 feet or more, although at the time the locality was visited by the writer the pits were filled with water. Several large piles of the excavated marl, however, were available for examination and the fauna recorded in the following list of species was collected:

ANTHOZOA.

Flabellum mortoni Vaughan.

BRACHIOPODA.

Terebratulina atlanticum (Mort.).

PELECYPODA.

Cucullaea sp.
Caryatis veta Whitf.

GASTROPODA.

Two undetermined species.

142[2]. This bed, two feet in thickness, is a nearly black greensand marl essentially like that below, but it contains an abundance of fossil shells, the following species being recognized:

BRACHIOPODA.

Terebratula harlani Mort.

PELECYPODA.

Gryphaea dissimilaris n. sp.
Polorthus tibialis (Mort.).

142[3]. The highest bed at the Hartshorn marl pits is a greensand marl similar to that below, 2½ to 3 feet in thickness, but with a distinctly greener color. It is filled with shells, all of which are stained a yellowish color, and the examples of *Terebratula* are much less common than in the bed below. The only species recognized in the fauna are:

BRACHIOPODA.

Terebratula harlani Mort.

PELECYPODA.

Gryphaea dissimilaris n. sp.

Locality 160.—Two miles north of Pemberton and a little over 1 mile southwest of Juliustown, an exposure of the Hornerstown marl has afforded the following fauna:

BRACHIOPODA.

Terebratula fragilis Mort.

PELECYPODA.

Graphaea sp.
Cardium knappi n. sp.

Locality 182.—From some old marl pits 1 mile southeast of Mullica Hill, the Terebratula bed of the Hornerstown marl has yielded the following:

BRACHIOPODA.

Terebratula harlani Mort.
Terebratula fragilis Mort.

PELECYPODA.

Gryphaea dissimilaris n. sp.

Locality 181. In the bank of the creek by the roadside, 2 miles northeast of Woodstown, and the same distance southwest of Harrisonville, the upper shell bed of the Hornerstown marl is exposed west of the road, all the contained fossils being stained a deep chocolate-brown color. The following species have been recognized:

BRACHIOPODA.

Terebratula harlani Mort.

PELECYPODA.

Gryphaea dissimilaris n. sp.
Gryphaeostrea vomer (Mort.).

ANALYTICAL DISCUSSION OF THE HORNERSTOWN FAUNA.

The total fauna of the Hornerstown marl is small and the fossils from that portion of the formation beneath the shell bed have been rarely met with. Whitfield has described two species of *Cucullaea* from the marl pits of J. S. Cook, near Tinton Falls, but no collections were secured by the writer from this locality. The same species, however, were found near Hornerstown

(Locality 152). The chief of these species is *C. vulgaris,* which may be a genetic successor of some member of the genus in the lower formations, possibly *C. tippana.*

The most important fauna from this lower portion of the formation was secured near New Egypt (Locality 142). Only three species could be definitely identified with any certainty, a coral, a brachiopod, and a pelecypod, all of which are specifically identical with forms occurring commonly in the Manasquan marl, the youngest member of the Cretaceous formations of New Jersey, immediately beneath the Shark River Eocene marl. A fourth species recognized at the same locality belongs to the genus *Cucullaea,* and is possibly *C. vulgaris,* the species which occurs at Tinton Falls and near Hornerstown, but the examples are all too imperfect for certain identification. The interesting fact in regard to this fauna is that it is totally different, in its essential characters, from the faunas of the subjacent formations from the Tinton down, and that it is the first appearance of a fauna which has its most typical expression in the Manasquan marl, at the very summit of the Cretaceous series.

The shell bed at the summit of the Hornerstown marl contains a fauna which is closely related to the fauna of the superjacent Vincentown beds, and it is possible that this shell bed should be considered as the basal portion of the Vincentown instead of the top of the Hornerstown, since it is frequently quite sandy and sometimes almost completely sand. Where the bed is highly glauconitic, it is not unlikely that it is only worked over and redeposited greensand from the beds below, after the initiation of the *Terebratula harlani* fauna in the region, being contemporaneous with nearly pure sand beds elsewhere, in the same general region. The *Terebratula harlani* which appears at this horizon in such abundance is clearly an immigrant from some other region, probably from Europe, since it does not extend into the south beyond Maryland and it has several more or less closely allied species in the European upper Cretaceous faunas. After its introduction at this time it becomes the dominant element in the faunas in the northern portion of the region at least, throughout the time of deposition of the Vincentown formation.

The *Gryphaea* associated with *Terebratula harlani* in this shell bed is a form similar to the earlier representives of the genus in the Cretaceous formations of the state, and doubtless was genetically related to them, although it has certain characters which seem to be constantly different from any of the lower forms and has been described in this report as a distinct species.

CHAPTER XIII.

THE VINCENTOWN FORMATION.

The Vincentown formation has two distinct lithologic facies. In Monmouth County it is the "yellow sand" bed of Cook, and is typically a bright yellow quartz sand, frequently with a small percentage of glauconite grains. Sometimes the formation is more ferruginous, with a redder color, with thin, irregular, iron-cemented beds and peculiar tubular iron concretions. The thickness of the formation in eastern Monmouth County is 40 to 50 feet. In tracing the formation towards the southwest, certain calcareous beds are seen to be included in it. Whether these beds are lenticular sheets or continuous layers cannot be determined from the limited exposures which are available for observation, but they continue to become more conspicuous in the direction indicated, until in Salem County the calcareous beds essentially replace the yellow sand beds of the northeast. This calcareous facies is what was called the Vincentown limesand by Clark, the name Vincentown being here extended to include also the sand facies. These calcareous beds are at times, especially in Monmouth County, a crumbling limesand, often with some quartz and glauconite grains, but in its more southwestern extension they usually consist of firm limestone layers with softer material interbedded. At several localities these harder layers have been quarried and burned for lime.

FAUNA OF THE VINCENTOWN FORMATION.

Fossils are usually rare or entirely absent in the exposures of the arenaceous facies of the formation, but somewhat full faunas have been collected from several localities. The calcareous facies of the formation is more often fossiliferous, and one locality near Vincentown has afforded a very large fauna.

Locality 122. In a road-cutting at Deal, just south of Whale Pond Brook, in a slight elevation known locally as California Hill, an excellent exposure of the "yellow sand" may be seen which is abundantly fossiliferous. This exposure is near the summit of the Vincentown formation, since the Manasquan marl occurs only a short distance south, down the dip. The fauna recognized here is as follows:

BRACHIOPODA.
Terebratula harlani Mort.

PELECYPODA.
Nemodon sp.
Cucullaea sp.
Axinea sp.
Ostrea sp.
Cardita sp.
Cardium knappi n. sp.
Caryatis sp.
Tellina sp.

Locality 111.—One mile southwest of Eatontown, at an exposure in the base of Gold Hill, this sand is abundantly fossiliferous, the following species being recognized:

ECHINODERMATA.
Spines of Echinoids.

BRYOZOA.
Onychocella digitata (Mort.)

BRACHIOPODA.
Terebratula harlani Mort.

PELECYPODA.
Graphaea sp.

Locality 134.—In the south bank of the Manasquan River at New Bargain Mills, 1.5 miles west of Farmingdale, near West

Farms, the Vincentown sand is well exposed and is highly fossiliferous. The bed at this locality is well towards the summit of the formation and has a larger content of glauconite than either of the other localities which have been mentioned. The fauna recognized at this locality is as follows:

ECHINODERMATA.
Salenia sp.
Cardiaster cinctus (Mort.).

BRYOZOA.
Onychocella digitata (Mort.).

PELECYPODA.
Nemodon sp.
Gryphaeostrea vomer (Mort.).
Cardium knappi n. sp.

A few rods down the stream from where the above fauna was collected, a bed in the same formation was recognized which is completely filled with examples of the bryozoan *Onychocella digitata,* with some plates and spines of Echinoids, the association being exactly that which is often seen in the Vincentown lime-sand, although the matrix in this case is a quartz and glauconitic sand with no lime.

Locality 146.—In the side of the road crossing Crosswicks Creek a little over 1 mile north of New Egypt, a yellow sand is well exposed on the west side of the creek, which has all the lithologic characters of the Vincentown sand in some of its exposures further east. At this point, however, the sand is apparently well down in the formation near the top of the subjacent Hornerstown marl. The fossil species recognized at this locality are:

BRACHIOPODA.
Terebratula harlani Mort.

PELECYPODA.
Gryphaea sp.

From New Egypt southwestward the calcareous facies of this formation becomes more and more conspicuous, and all the fossiliferous localities from which collections have been made are in the limesand or limestone.

Locality 143.—In the banks of a small stream west of the railroad track a little over ½ mile northeast of the station at New Egypt, the Vincentown limestone is exposed and has yielded the following species of fossils:

ANTHOZOA.
Undetermined coral.

ECHINODERMATA.
Echinoid spines, several species.

BRYOZOA.
Undetermined species.

PELECYPODA.
Gryphaea sp.
Gryphaeostrea vomer (Mort.).
Periplomya sp.
Tenea ? sp.
Cardium knappi n. sp.
Caryatis veta Whitf.
Gastrochaena americana Gabb.

GASTROPODA.
Several undetermined species.

Locality 151.—From an exposure of the Vincentown limesand just south of the railroad trestle east of the station at Cookstown specimens of *Pinna rostriformis* Mort. were recognized, along with several other pelecypoda and some bryozoa.

Locality 154.—On the north bank of Rancocas Creek, a quarter of a mile northwest of Vincentown, a decomposed layer of

the Vincentown limesand is exposed. This material, on washing, has yielded a large fauna as follows:

PROTOZOA.[1]

Haplophragmium irregulare (Roem.).
Textularia agglutinans d'Orb.
Textularia agglutinans var. *porrecta* Brady.
Textularia gramen d'Orb.
Textulara sagittula Defrance.
Textularia turris d'Orb.
Verneuilina triquetra (Münster).
Gaudryina pupoides d'Orb.
Lagena globosa (Montagu).
Vitrewebbina sollasi Chap.
Vitrewebbina laevis (Sollas).
Nodosaria acuminata (Reuss).
Nodosaria annulata Reuss.
Nodosaria consobrina var. *emaciata* (Reuss).
Nodosaria laevigata d'Orb.
Nodosaria obliqua (Linné).
Nodosaria rotundata (Reuss).
Nodosaria zippei Reuss.
Lingulina carinata d'Orb.
Frondicularia alata d'Orb.
Frondicularia angusta var. *dimidia* Bagg.
Frondicularia archiaciana var. *strigillata* Bagg.
Frondicularia major Bornemann.
Frondicularia ovata Rœmer.
Cristellaria acutauricularis (F. & M.).
Cristellaria articulata (Reuss).
Cristellaria cassis (F. & M.).
Cristellaria crepidula (F. & M.).
Cristellaria cretacea Bagg.
Cristellaria gibba d'Orb.
Cristellaria projecta Bagg.
Cristellaria rotulata (Lam.).

[1] This list of species of Foraminfera is for the most part compiled from Bagg, Bull. U. S. G. S., No. 88.

Cristellaria wetherellii (Jones).
Flabellina cordata Reuss.
Flabellina saggitaria (Lea).
Polymorphina compressa d'Orb.
Polymorphina communis (d'Orb.).
Polymorphina gibba (d'Orb.).
Polymorphina lactea (W. & J.).
Polymorphina orbignii (Zborz.).
Globigerina bulloides d'Orb.
Globigerina bulloides var. *triloba* Reuss.
Globigerina cretacea d'Orb.
Truncatulina haidingerii (d'Orb).
Anomalina ammonoides (Reuss).
Pulvinulina karsteni (Reuss).

ECHINODERMATA.

Rhizocrinus cylindricus n. sp.
Goniaster mammillata Gabb.
Cidaris splendens Mort.
Cidaris walcotti Clark.
Pseudodiadema diatretum (Mort.).
Cardiaster cinctus Mort.

VERMES.

Serpula rotula (Mort.).

BRYOZOA.[1]

Stomatopora regularis G. & H.
Stomatopora kümmeli U. & B. n. sp.
Stomatopora temnichorda U. & B. n. sp.
Berenicea americana U. & B. n. sp.
Discosparsa varians Ulr.
Diastropora lineata G. & H.
Reticulipora sagena G. & H.
Reticulipora dichotoma G. & H.
Crisina striatopora Ulr.

[1] For the identification of these bryozoans I am under obligation to Dr. R. S. Bassler.

Bisidmonea gabbiana U. & B n. sp.
Idmonea abbotti G. & H.
Filisparsa contortilis (Lons.).
Filisparsa bifurcata U. & B. n. sp.
Entalophora conradi G. & H.
Spiropora calamus G. & H.
Clausa americana G. & H.
Filifascigera megaera (Lons.).
Discocytis eccentrica U. & B. n. sp.
Heteropora parvicella (G. & H.).
Retelea ovalis G. & H.
Flustrella ? capistrata G. & H.
Onychocella digitata (Morton).
Biflustra torta G. & H.
Biflustra disjuncta G. & H.
Amphiblestrum heteropora (G. & H.).
Membranipora plebia G. & H.
Membranipora annuloidea U. & B. n. sp.
Membranipora nematoporoides U. & B. n. sp.
Membranipora jerseyensis U. & B. n. sp.
Membranipora perampla G. & H.
Pyripora irregularis G. & H.
Planicellaria oculata d'Orb.
Planicellaria cylindrica G. & H.
Escharinella altimuralis U. & B. n. sp.
Reptomulticava cepularis G. & H.
Cribrilina sagena (Mort.).
Cribrilina immersa G. & H.
Membraniporella abbotti (G. & H.).
Membraniporella distans (G. & H.).
Reptoporina carinata G. & H.
Reptescharellina prolifera G. & H.
Micropora cylindracea U. & B. n. sp.
Micropora pulchra U. & B. n. sp.
Micropora ? vincentownensis U. & B. n. sp.
Microporella sparsipora U. & B. n. sp.
Monoporella exserta (G. & H.).
Porina labiata (G. & H.).

Porina quadrangularis G. & H.
Porina coronata (Reuss)?
Lepralia aspera G. & H.
Mucronella muralis (G. & H.).
Mucronella typica (G. & H.).
Mucronella aspera Ulr.
Mucronella pumila (G. & H.).

BRACHIOPODA.
Cistella beecheri Clark.
Platidia cretacea n. sp.

PELECYPODA.
Gryphaea sp.
Gryphaeostrea vomer (Mort.).
Polorthus tibialis (Mort.)

GASTROPODA.
Pleurotrema solariformis Whitf.

CRUSTACEA.
Callianassa sp.

In addition to the above species, the following are recorded from this formation at Vincentown, but have not been collected by the writer:

ECHINODERMATA.
Pentacrinus bryani Gabb.
Pentaceros asperulus Clark n. sp.
Salenia tumidula Clark.
Trematopygus crucifer (Mort.)
Ananchytes ovalis Clark.
Hemiaster parastatus (Mort.).
Hemiaster stella (Mort.)
Hemiaster ungula (Mort.)
Linthia tumidula Clark.

Locality 161.—At Medford, along the creek just west of the town, the Vincentown limesand is exposed, and the following species of fossils have been recognized:

ECHINODERMATA.
Pseudodiadema diatrema (Mort.)
Echinoid spines.

VERMES.
Serpula rotula (Mort.)

BRYOZOA.
Onychocella digitata (Mort.)
Retelea ovalis G. & H.
Several undetermined species.

PELECYPODA.
Polorthus tibialis (Mort.)

Locality 171.—On Mantua Creek, just below the mouth of Bethel run, near Hurffville, the following species were collected from the Vincentown limesand:

BRYOZOA.
Onychocella digitata (Mort.)

PELECYPODA.
Arca quindecemradiata Gabb.
Gryphaeostrea vomer (Mort.)
Polorthus tibialis (Mort.)

Locality 170.—This locality is situated about ½ mile up the creek from the last, and has yielded the following species:

VERMES.
Serpula rotula (Mort.)

BRYOZOA.
Onychocella digitata (Mort.)

PELECYPODA.

Ostrea bryani Gabb?
Gryphaeostrea vomer (Mort.)
Polorthus tibialis (Mort.)

CRUSTACEA.

Scalpellum conradi Gabb.

Locality 196.—Along a small stream northwest of Alloway station, the Vincentown formation is well exposed. In places it is a hard yellow limestone, and has been quarried for the purpose of burning into lime, and from one such quarry, 1.5 miles northwest of the station, the following fossils have been identified:

ANTHOZOA.

Undetermined coral.

PELECYPODA.

Nemodon sp.
Arca sp.
Gryphaeostrea vomer (Mort.)
Pecten sp.
Cardium knappi n. sp.
Caryatis veta Whitf.

GASTROPODA.

Calyptraea sp.
Several undetermined species.

ANALYTICAL DISCUSSION OF THE VINCENTOWN FAUNA.

There are really two faunas to be considered in this discussion, or at least two quite distinct facies of the same fauna, one occurring in the sand and the other in the calcareous facies of the formation. The fauna of the sand is especially characterized by *Terebratula harlani,* this species being present throughout the entire formation, wherever fossils occur, and it is usually associated with more or less imperfectly preserved casts of a species of *Gryphaea.* This association of species is essentially the same

as that of the shell layer at the summit of the Hornerstown marl, and, as has already been pointed out, this shell layer should, perhaps, be considered as the base of the Vincentown rather than as the top of the Hornerstown. The most extensive fauna of this sand facies has been collected near Deal (Locality 122), from near the summit of the formation, where, associated with *T. harlani,* by far the most abundant member of the fauna, are several species of pelecypods, of which species of the genera *Nemodon, Cucullaea* and *Axinea* are somewhat closely related to members of the same genera in the lower faunas. Scattered through the Vincentown sand, fragments of bryozoa and spines of echinoids are not infrequently met with, forms which belong rather to the calcareous facies of contemporaneous age. At one locality on the Manasquam River west of Farmingdale (Locality 134), although the bed is arenaceous, but with a higher content of glauconite than usual, the fauna is essentially the bryozoan and echinoid fauna of the typical Vincentown calcareous beds.

The fauna of the Vincentown limesand is unique among the Cretaceous faunas of New Jersey. Calcareous bryozoans are abundant, in some beds constituting locally a very large percentage of the total calcareous matter, no less than 54 species of these organisms being recognized in the fauna at one locality near Vincentown. Associated with these bryozoans are many echinoids, and large numbers of shells of foraminifera. In other localities where the bryozoans and echinoids are less conspicuous, or nearly absent, *Gryphaeostrea vomer,* a species commonly present in the Marshalltown and Navesink faunas, is the most conspicuous member of the fauna, associated with which *Pholorthus tibialis* is frequently present. In the denser limestone layers of the formation at some points, several species of pelecypods and gastropods are present, but on the whole, the molluscan element in the fauna is not large in the number of species. Some of the species of molluscs, such as *Cardium knappi* and *Caryatis veta,* occur also on the subjacent Hornerstown marl and in the superjacent Manasquan marl, although in the main the species of the entire Vincentown are different from those of the Hornerstown and the Manasquan.

CHAPTER XIV.

THE MANASQUAN MARL.

The Manasquan marl is the youngest Cretaceous formation in New Jersey, and is restricted to the northeastern half of the Cretaceous belt in the State. The formation is most typically developed in eastern Monmouth County, especially in the vicinity of Farmingdale, and is gradually overlapped by later formations, so that it practically disappears entirely in Camden County a short distance from the boundary between Burlington and Camden counties. Lithologically the formation is a nearly pure greensand marl of a dark-green color, with at times a mixture of clayey material. The formation is somewhat sharply differentiated from the subjacent Vincentown formation, but it passes almost imperceptably into the superjacent Shark River marl of Eocene age. This marl bed has a maximum thickness of nearly 50 feet in the northeastern portion of its area, which diminishes to the southwest, being reduced to about 30 feet near the southwestern boundary of Burlington County.

FAUNA OF THE MANASQUAN MARL.

The fossils of the Manasquan marl are not abundant and are frequently poorly preserved. During the prosecution of the field work undertaken in connection with the preparation of the present report, collections have been made from but three localities.

Locality 138.—From the heaps of marl at the pits along the Manasquan River, 1 mile south of Farmingdale, the following fossils have been collected:

ANTHOZOA.

Flabellum mortoni Vaughan.
Trochocyathus conoides (G. & H.).
Balanophyllia inauris Vaughan.

BRACHIOPODA.
Terebratulina atlantica (Mort.)

PELECYPODA.
Ostrea bryani Gabb.
Pecten sp.
Modiola johnsoni Whitf.
Etea delawarensis (Gabb).
Crassatellites littoralis (Con.)
Caryatis veta Whitf.

GASTROPODA.
Rostellaria biconicus Whitf.

VERTEBRATA.
Shark's teeth.
Sting of Ray.

Locality 155.—From the heaps of marl at the marl pits 2 miles southwest of New Egypt, the following fossils have been collected:

ANTHOZOA.
Balanophyllia inauris Vaughan.

PELECYPODA.
Ostrea bryani Gabb.
Crassatellites littoralis (Con.).
Caryatis veta Whitf.

GASTROPODA.
Rostellaria biconicus Whitf.

VERTEBRATA.
Shark's teeth.
Fish vertebra.

Locality 159.—From the heaps of marl at the group of pits a little less than 1 mile south of Vincentown, the following fossils have been identified:

PELECYPODA.

Ostrea bryani Gabb.
Caryatis veta Whitf.
Teredo sp.
Polorthus tibialis (Mort.).

VERTEBRATA.

Shark's teeth.
Fish vertebra.

ANALYTICAL DISCUSSION OF THE MANASQUAN FAUNA.

As shown in the lists of species collected from the above localities, the fauna of the Manasquan marl is totally different from the faunas of the beds lying below the Hornerstown marl. There is, however, a distinct recurrence of species from the Hornerstown. One of the conspicuous elements in the fauna are the small, simple, horn corals, of which three species are recognized, one of the most common of them, *Flabellum mortoni,* being also present in the Hornerstown. *Terebratulina atlantica* and *Caryatis veta* are two other species of the Manasquan fauna which occurred earlier in the Hornerstown marl, and of these three species only *Caryatis veta* has been observed in the intervening Vincentown formation. Although the known fauna of the Manasquan is larger than the yet known fauna of the Hornerstown marl beneath the shell layer at the summit of that formation, yet the evidence seems to be sufficient to permit the assumption that the Manasquan fauna in its essential characters is a recurrence of the fauna of the Hornerstown, with some modifications of course, due to the recurrence in the same region of similar physical conditions. The fauna had doubtless persisted somewhere in the adjacent Cretaceous sea, where the physical conditions were favorable for it, during the entire intervening time.

CHAPTER XV.

CLASSIFICATION AND CORRELATION OF THE CRETACEOUS FAUNAS OF NEW JERSEY.

A critical analysis of the entire series of marine Cretaceous faunas of New Jersey leads to the conclusion that but two major paleontologic divisions can be recognized. Continued investigation of the faunas has shown that the recognition of four major divisions, as proposed by Clark,[1] and as previously accepted with some modifications by the writer,[2] does not properly represent the true conditions in the history of the faunas. It has been shown in the series of summary tables given in the preceding pages for each of the faunas from the Cliffwood to the Tinton, inclusive, how intimate are the relations between them all. Not one of them but which contains a greater or less number of species common to each of the others, and although different elements are present in these faunas, which are developed in varying degrees in different members of the faunal series, yet the interrelationship between all is very close. From the faunal point of view the recognition of a Matawan division and a Monmouth division in New Jersey is strictly arbitrary and unnatural. Some species, to be sure, are restricted to the lower formations of the series and others to the upper, but there is no assemblage of forms which can properly be said to constitute a Matawan fauna and another a Monmouth fauna, which are any more distinct in character than the faunas of successive formations.

[1] Matawan, Monmouth, Rancocas and Manasquan.

[2] Jour. Geol., vol. 13, pp. 71-84; Geol. Surv. N. J., Am. Rep. State Geol. for 1904, pp. 145-159.

If the foreign Belemnitella element introduced in the Mount Laurel-Navesink fauna had persisted, and had supplanted in any notable degree the older faunas in the region, instead of being a minor, although important episode in the faunal history, merely being one element in a fauna which as a whole was closely related to an earlier one, and which was followed by another one in which the Belemnitella element was absent, and which was essentially a recurrence of an earlier fauna, then there would be good paleontological reasons for recognizing the Matawan and Monmouth as distinct major divisions. But this is not the case.

Neither are there two distinct lithologic divisions in New Jersey which can be properly designated as the Matawan and Monmouth formations. In fact the accepted line between these two divisions cannot be mapped with any accuracy through a large portion of its extent in New Jersey, and although a very important greensand marl deposit is included in the Monmouth, yet in the Matawan the Marshalltown formation is for the southern half of its outcrop so nearly a pure greensand marl that it was mistaken by Cook in the earlier investigations of the Survey for the marl bed of the Monmouth, *i. e.*, the Navesink marl of Monmouth County. The Merchantville formation, also, in some places, contains so much glauconite that it has been dug for fertilizing purposes. On the other hand, the Mount Laurel and Red Bank sands of the Monmouth are formations which, for the most part, are as free from glauconite as any of the formations of the Matawan division. With a full consideration of the data involved, there seems to be no utility whatever in New Jersey for the recognition of divisions to be known as the Matawan and Monmouth, except possibly as an aid in correlating the New Jersey formations with those found farther south.

The discovery in the Hornerstown marl of a fauna having the essential characters of that of the Manasquan marl removes all paleontological foundation for the recognition of the two major divisions, Rancocas and Manasquan, for the upper portion of the series.

The line separating the two natural paleontological divisions, which have been indicated, lies between the Tinton and the Hornerstown formations of Monmouth County, but to the south,

where the Red Bank and Tinton have thinned out, and the Navesink and Hornerstown marls are in juxtaposition, this line cannot be sharply located stratigraphically. It seems to be important that certain definite names be applied to these two major faunas, yet none of the names heretofore used in New Jersey are at all applicable to either of the divisions. It will be noticed on examining the tables of distribution of the faunas from the Cliffwood to the Tinton, given above, that in each fauna a considerable number of species have an extra-territorial distribution, and by far the larger number of these species which occur outside of New Jersey are known from the upper Cretaceous formations of the Gulf-border region, in the Ripley and associated formations of Alabama, Mississippi, Texas, etc. The community of species between this southern region and New Jersey is so marked that no doubt can be entertained as to the essential time equivalence of the formations and faunas of the two regions, and because of the typical development of the faunas in the Ripley formation this series may be designated by the name Ripleyian.

The higher fauna recognized in the Cretaceous formations of New Jersey appears to have its typical development in this State. Its most conspicuous faunule is the one characterized by *Terebratula harlani,* but south of Maryland this fauna has not been recognized, although the species *T. harlani* has been identified from some of the Eocene beds of the south. This higher fauna may therefore be designated as the Jerseyian.

The Ripleyian fauna in New Jersey characterizes all the marine beds up to the top of the Tinton, including the Magothy below. The subordinate formations carrying this fauna are without doubt strictly local, as is shown even in their distribution in New Jersey, where the Englishtown and Red Bank formations do not continue entirely across the State. In Maryland, as has been shown by Clark, the New Jersey formations described above cannot all be recognized, yet the Ripleyian fauna is clearly defined. In the States further south the local formations vary, their lithologic characters, whether sand, clay, or calcareous material, being dependent upon the local conditions which

obtained at the various localities during this period. In the south, at least east of the Mississippi River, all the marine Upper Cretaceous faunas seem to be of Ripleyian age, although it is, of course, possible that a thorough investigation of the faunas of that region will necessitate some modification of this interpretation.

The Ripleyian fauna as seen in New Jersey is a complex assemblage of organisms with two or more distinct facies, which were doubtless associated with different environmental conditions, such as depth of water, character of the sea bottom, etc. As has been pointed out, two distinct facies of the fauna have here been distinctly recognized, one of which, the *Cucullaea* fauna, as it has been called in the preceding pages, is characteristic of the more glauconitic beds, the Merchantville, Marshalltown, Navesink and Tinton. The second faunal facies, characterized by *Lucina cretacea* or its associates, occurs in the clays and sandy clays of the Cliffwood, Woodbury, Wenonah and Red Bank formations. In the existing seas the areas where glauconitic sands are being formed under the most favorable conditions are some distance off shore at depths beyond the action of waves and currents, and at sufficient distance from the mouths of rivers to be comparatively free from terrigenous sediments.[1] The sands and clays, on the other hand, are deposited nearer shore. The faunas associated with the two types of sediments in the New Jersey Cretaceous beds were doubtless characteristic of the deeper and the shallower waters. The existence, therefore, of these two alternating faunal facies with the particular types of sediments with which they are associated, within the present belt of outcrop of the Cretaceous in New Jersey, necessitates the assumption that the Cretaceous shore across the present area of New Jersey was subjected to a series of oscillations, being alternately elevated and depressed. During the periods of depression the deeper waters, with the accompanying glauconitic sediments and the *Cucullaea* fauna, gradually crept to the northwest and occupied a belt which had formerly been inhabited by the shallower water fauna, and where

[1] For a discussion of the "Origin of Greensand" see Geol. Surv. N. J., Ann. Rep. of State Geol. for 1892, pp. 218-239.

more clastic sediments had been deposited. At a later period of emergence the deeper-water fauna would shift to the southeast and the shallower-water fauna would again occupy the region it had formerly occupied. These conditions furnish a rational explanation for the recurrence of the two essential elements in this fauna in New Jersey, as well as for the more or less intimate mingling of the two faunal elements which is observed in certain horizons. Since there could have been no hard and fast line separating the shallower and deeper-water faunas, members of the shallower-water fauna were free to wander into the deeper waters, and the deeper-water forms into the shallower waters, while in the belt of intermediate depth there was of necessity a mingling of the two faunal elements.

If the conditions here postulated are the true interpretation of the conditions in New Jersey during the existence here of the Ripleyian fauna, the shallower-water formations should, on being traced down the dip, gradually become more glauconitic, and at some distance in this direction the entire series of sediments might be found to be glauconitic in character. On the other hand, the more glauconitic formations as seen under present conditions of exposure, must originally have had their shallower-water equivalents characterized by the absence of glauconite and by the shallower-water fauna, which has been entirely removed by erosion since Cretaceous time.

That the oscillations of the Cretaceous coast across New Jersey were but local phenomena is shown in the case of the Red Bank formation, which cannot be recognized beyond Monmouth County, a fact indicating that the elevation which brought about the change from Navesink to Red Bank conditions was limited to the northeastern portion of the area, while farther southwest the deeper waters continued with the accompanying glauconitic deposits. In this more southwestern region the depression accompanying the Navesink marl of eastern Monmouth County was not so marked since the more clastic Mount Laurel sand, apparently a shallower-water formation, was, in part at least, contemporaneous with it.

In tracing these elements of the Ripleyian fauna beyond the limits of New Jersey the local details in their history will not

necessarily be found to conform with their history in New Jersey. The alternation of the two faunal facies may or may not occur. In certain regions it may be found that the one or the other facies persists through the period, or if the alternation does occur, the recurrences may be less or more frequent than has been observed in New Jersey. In tracing their relationships with other Cretaceous faunas in North America, it is found that they have a close analog in the faunas of the Montana group of the West and Northwest. Just as in the New Jersey area an alternation of shallower and deeper-water faunas is a conspicuous feature, so in the Northwest a shallower-water fauna described first as the "Fox Hills" fauna and supposed to be characteristic of the upper division of the Montana, has been found to be recurrent at various horizons throughout the entire Montana series. In regard to this fauna Stanton says "Faunas similar to that of the Fox Hills sandstone have a great vertical range and are likely to be found at any horizon within the Montana group where a littoral or shallow-water facies is developed."[1]

A comparison of the shallower-water facies of the Ripleyian fauna in New Jersey with this Fox Hills fauna of the Northwest shows many characteristics in common. The following Fox Hills species have been identified in these New Jersey faunas: *Micrabacia americana, Cuspidaria ventricosa, Cymella undata, Pteria petrosa.* Many others of the New Jersey species are clearly allied very closely to Fox Hills forms, and further critical studies with the comparison of large collections from the two areas will doubtless lead to the recognition of many more species common to the two faunas.

The deeper-water *Cucullaea* fauna of the New Jersey area does not so clearly correspond with the deeper-water Pierre fauna of the northwestern Montana group, this fauna in New Jersey, as well as the shallower-water facies, having much in common with the Fox Hills fauna of that region. However, certain genera such as *Inoceramus* and the oyster-like forms are more characteristic of the deeper-water facies in both regions.

In connection with the present investigation of the New Jersey faunas it has not been practicable to make as extensive nor as

[1] Bull. U. S. G. S., No. 257, p. 66.

critical comparisons of the fauna with those of the Montana group as would be highly desirable, but enough has been seen to show that the relationships are close, far closer than would be suggested by a mere comparison of the species here considered as identical, and future studies will surely show many more identical species as well as many which are closely allied. These relationships are so close, in fact, that the name Montanan might perhaps be extended to embrace the faunas and their including sediments.

In Europe the Cretaceous fauna which seems to be most closely allied to this Ripleyian fauna of New Jersey and the Gulf-border region is that of the Cretaceous beds at Aachen. This fauna has been elaborately described and illustrated by Holzapfel[1], and when the opportunity is given for a critical comparison of collections from these Aachen beds with collections of our American forms, a considerable number of species will doubtless be found to be common to the faunas. The Aachen beds are of Senonian age, and in their upper portion are characterized by *Belemnitella mucronata*, a close analog, as has been pointed out, of the New Jersey *B. americana*. Furthermore, this Belemnitella zone is highly characteristic of the higher Senonian beds of England, France and Germany, and the occurrence of the zone on opposite sides of the Atlantic is without doubt essentially contemporaneous, although in Europe it probably represents a longer time interval than in America.

In "An approximate correlation of the Atlantic coast Cretaceous formations" suggested by Clark,[2] his Matawan and Monmouth divisions are referred to the Senonian, the Cliffwood beds being considered as Cenomanian and the Raritan proper as Albian, these latter correlations being based primarily upon floral evidence. From the evidence of the invertebrate fossils, however, as shown in the earlier pages of this report, the Cliffwood clays cannot be removed from association with the superjacent beds. As to the Raritan the invertebrate evidence is too meagre to be of

[1] Die Mollusken der Aachener Kreide, von E. Holzapfel, Palaeontographica, vol. 34, pp. 29-180, plates 4-20; vol. 35, pp. 139-268, plates 8-29.

[2] Am. Jour. Sci., (4), vol. 18, p. 440.

practical use in correlation, and the correlation of that formation must rest upon the evidence of the fossil plants.

The Hornerstown, Vincentown and Manasquan formations do not, in general, afford so extensive faunas as do the lower formations. The period was introduced with a nearly pure greensand marl formation, which, southwest of the point where the Red Bank and Tinton formations can be differentiated, is apparently continuous with the subjacent glauconitic deposits. During the middle portion of the period there was apparently an elevation of the coast, and in the belt which formerly received the deeper-water glauconitic sediments, the shallower-water Vincentown sediments were deposited. During the closing epoch of the period the coast was again depressed as is shown by the recurrence of the glauconitic sediments in the Manasquan, and with the return of similar conditions a recurrence of the life of the Hornerstown marl is seen in the Manasquan.

These beds or their equivalents seem to be absent in the Gulf-border region south of Maryland, in fact, no faunas related to the Jerseyian fauna being recognized elsewhere in North America. It is not improbable, however, that certain of the non-marine, higher Cretaceous beds of the west may have been formed contemporaneously with the marine beds containing the Jerseyian fauna.

As has been pointed out by Clark,[1] the faunas of this higher division of the New Jersey Cretaceous, referred by him to the two divisions, Rancocas and Manasquan, but considered here as comprising a single paleontological division, the Jerseyian, show certain affinities with the lower or Maestrichtian division of the Danian series of the western European Cretaceous. The faunas of the Hornerstown and Manasquan marls are in general too meagre and too poorly preserved to allow of any satisfactory comparison with foreign faunas, neither does the fauna of the arenaceous facies of the Vincentown afford much for comparison with European faunas. A comparison, however, of the extensive bryozoan fauna of the Vincentown limesand with similar bryozoan faunas of typical Maestricht beds shows a remarkably

[1] Geol. Surv. N. J., Ann. Rep. State Geol. for 1897, p. 207.

close relationship. The genera are largely the same and many of the species also are either identical or closely allied in the two faunas, and when critical comparisons can be made of the American and European collections several and perhaps many of the American species will probably be shown to be synonyms. From this evidence of the bryozoans the lower Danian or Maestrichtian age of the Vincentown can be safely assumed, and with this correlation the Danian age of the entire Jerseyian fauna may be safely implied.

PART II.

Descriptive Paleontology.

CHAPTER I.[1]

Branch PROTOZOA.

Class RHIZOPODA.

Order FORAMINIFERA.

Family LITUOLIDÆ.

Sub-family LITUOLINÆ.

Genus HAPLOPHRAGMIUM Reuss.

Haplophragmium concavum Bagg.

Plate I., Figs. 1–2.

1898. *Haplophragmium concavum* Bagg., Bull. U. S. G. S., No. 88, p. 27, pl. 2, figs. 1 a-b.

Description.—"Test arenaceo-siliceous, rough, of a dull-gray color; consisting of eight or nine chambers, which are concave upon their inner margin, giving the form an approximately tri-

[1] This chapter on the Protozoa has been taken almost in its entirety from Bulletin No. 88 of the United States Geological Survey, "The Cretaceous Foraminifera of New Jersey," by Dr. R. M. Bagg. Figures have been added, however, to illustrate many of the species, copied for the most part from the Challenger Report on the Foraminifera. In using these figures for purposes of identification it must always be kept in mind that they were drawn from recent specimens, and that they will often differ somewhat in appearance from fossil specimens. It is believed, however, that these figures will be of material assistance to those wishing to identify the species.

In recording the formations and localities of the species, Bagg has been followed, although the names of the formations have been changed to correspond with the usage in the present volume. In most cases it has been clear from the original references from what formations, here recognized, the species were collected, but in the cases of those forms recorded from the "Rancocas" it has not always been clear whether the specimens came from the Hornerstown marl or the Vincentown limesand. In consequence of this, a few errors may have crept into the formation records here given.

In recording the geographic distribution of the species no attempt has been made to go beyond North America, but in the case of those forms which have also been recognized in the Tertiary formations of America, such occurence has been noted.

angular outline in transverse section; chambers variable in size; ultimate chamber largest and very slightly elevated in the central portion; septal lines straight, marked by definite deep constrictions; aperture a large elongated oval opening, situated toward the outside edge of the ultimate chamber and nearer the convex side.

"Length, 1 mm.; breadth, 0.43 mm." (Bagg.)

Formation and locality.—Hornerstown marl, Blue Ball (Bagg).

Geographic distribution.—New Jersey.

Haplophragmium irregulare (Rœmer).

1840. *Spirolina irregularis* Rœmer, Verstein. norddeutsch. Kreide, p. 98, pl. xv, fig. 29.

1860. *Haplophragmium irregulare* Reuss, Sitz. Akad. Wiss. Wien., vol. xl, p. 219, pl. x, fig. 9; pl. xi, fig. 1.

1898. *Haplophragmium irregulare* Bagg, Bull. U. S. G. S., No. 88, p. 27.

Description.—"Test arenaceous, rough, flask-shaped; chambers unequal and irregular, at first involute, then evolute and arranged in an elongated series, closely set, numerous (about fifteen), narrow, separated by straight depressed septa; aperture divided.

"Length, 2.6 mm.; breadth, 0.6–0.9 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Sub-family TROCHAMMININÆ.

Genus TROCHAMMINA Parker and Jones.

Trochammina inflata (Montagu).

Plate I., Figs. 3–5.

1808. *Nautilus inflatus* Montagu, Test. Brit. Suppl., p. 81, pl. xviii, fig. 3.

1884. *Trochammina inflata* Brady, Chal. Rept., vol. ix, p. 338, pl. xli, fig. 4, a-c.

1898. *Trochammina inflata* Bagg, Bull. U. S. G. S., No. 88, p. 27.

Description.—"Test free; trochoid or convex, depressed, rotaliform; consisting of about three convolutions, the outermost of which is formed of five or six very ventricose segments with deeply excavated septal lines. Inferior face somewhat concave, with sunken umbilicus; peripheral margin lobulated. Aperture small, arched; situated on the inferior side of the final segment, close to the previous convolution, a little within the periphery. Color pale brown, the small primary segments much darker than the rest." (Brady.)

Remarks.—"The above description agrees closely with the New Jersey specimens, but the color is rather a yellowish white than a brown, and the external view shows only two convolutions instead of three, as in Professor Brady's figure.

"Diameter, 0.43 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Timber Creek, near Mullica Hill (Bagg).

Geographic distribution.—New Jersey.

Family TEXTULARIDÆ.

Sub-family TEXTULARINÆ.

Genus TEXTULARIA Defrance.

Textularia agglutinans d'Orbigny.

Plate I., Figs. 6–7.

1839. *Textularia agglutinans* d'Orbigny, Foram. Cuba, p. 136, pl. i, figs. 17, 18, 32–34.

1884. *Textularia agglutinans* Brady, Chal. Rept., vol. ix, p. 363, pl. xliii, figs. 1–3; var., figs. 4, 12.

1898. *Textularia agglutinans* Bagg, Bull. U. S. G. S., No. 88, p. 28.

1898. *Textularia agglutinans* Bagg, Bull. Am. Pal., vol. 2, No. 10, p. 19 (313).

1904. *Textularia agglutinans* Bagg, Md. Geol. Surv., Miocene, p. 470, pl. 132, fig. 5.

Description.—"Test agglutinous, elongated, of a dull gray color, laterally convex; chambers rather numerous, ten to twelve in long specimens; septa nearly straight; aperture semilunar.

"Length, 2.37 mm." (Bagg).

Remarks—"This is a rather common species at Vincentown, where it occurs in the "lime sand." It is interesting to see the small, smooth glauconite grains which help to form the shell substance." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Mullica Hill, Timber Creek, (Bagg); Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey; Miocene of Maryland.

Textularia agglutinans var. porrecta Brady.

Plate I., Figs. 8–9.

1884. *Textularia agglutinans* var. *porrecta,* Brady, Chal. Rept., vol. ix, p. 364, pl. xliii, fig. 4.

1898. *Textularia agglutinans* var. *porrecta* Bagg, Bull. U. S. G. S., No. 88, p. 28.

Description.—"Test much elongated, agglutinous, of nearly uniform width; chambers more numerous than in *Textularia agglutinans,* otherwise both forms are very similar.

"The New Jersey specimens are not quite so elongated as the figure in the *Challenger* Report.

"Length, 2 mm.; breadth, 0.6 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown. (Bagg.)

Geographic distribution.—New Jersey, Canada.

Textularia gibbosa d'Orbigny.

1826. *Textularia gibbosa* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 262, No. 6.

1891. *Textularia gibbosa* Terrigi, Mem. R. Com. G. Regno, vol. iv, pt. 1, p. 68, pl. i, fig. 10.

1898. *Textularia gibbosa* Bagg, Bull. U. S. G. S., No. 88, p. 29.

Description.—"Test ovate elongate, smooth, of a dull-gray color; transverse section round; shell composed of only four chambers in each series; septal lines arched, scarcely discernible externally; aperture a median semi-lunar arch in the ultimate segment.

"Length, 0.9-1 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg).

Geographic distribution.—New Jersey.

Textularia globulosa Ehrenberg.

Plate I., Figs. 10–12.

1839. *Textularia globulosa* Ehrenberg, Abhandl. k. Ak. Wiss. Berlin (1838), p. 135, pl. iv, fig. b.

1885. *Textularia globulosa* Woodward and Thomas, 13th Ann. Rept. Geol. Nat. Hist. Survey Minnesota for 1884, p. 166, pl. iii, figs. 1–5.

1895. *Textularia globulosa* Woodward and Thomas, Pal. Minn., vol. 1, p. 29, pl. C, figs. 1-6.

1898. *Textularia globulosa* Bagg, Bull. U. S. G. S., No. 88, p. 29.

Description.—"Test small, consisting of a few smooth, spherical, or globular chambers; suture lines deep; shell posteriorly acute, anteriorly obtuse.

"Length unknown." (Bagg).

Remarks.—"It has been impossible to find shells in perfect preservation, since the constrictions between the chambers are so pronounced that the chambers are easily broken off, but the few globular chambers we do find are sufficient for the determination of the species." (Bagg.)

Formation and locality.—Navesink marl, Freehold (rare) (Bagg).

Geographic distribution.—New Jersey, Minnesota.

Textularia gramen d'Orbigny.

Plate I., Figs 13–14.

1846. *Textularia gramen* d'Orbigny, Foram. Foss. Bassin tert. Vienne, p. 248, pl. xv, figs. 4–6.

1884. *Textularia gramen* Brady, Chal. Rept., vol ix, p. 365, pl. xliii, figs. 9, 10.
1898. *Textularia gramen* Bagg, Bull. U. S. G. S., No. 88, p. 29.
1898. *Textularia gramen* Bagg, Bull. Am. Pal., vol. 2, No. 10, p. 313.
1904. *Textularia gramen* Bagg, Md. Geol. Surv., Miocene, p. 471, pl. 132, figs. 8–9.

Description.—"Test arenaceous, rough externally, stoutly built, laterally compressed, margin subangular; five to six wide chambers, very slightly convex; posterior end neatly rounded; general outline very similar to *Textularia hauerii,* but distinguished from that species by its more angular lateral edges, and differing from *Textularia abbreviata,* which it also resembles, in being less short and thick.

"Length, 1 mm.; breadth, 0.52 mm." (Bagg).

Formation and locality.—Vincentown limesand, Vincentown, Timber Creek (Bagg).

Geographic distribution.—New Jersey; Miocene of Maryland.

Textularia sagittula Defrance.

Plate I., Figs. 15–17.

1824. *Textularia sagittula* Defrance, Dict. Sci. Nat., vol. xxxii, p. 177; 1828, vol. liii, p. 344; Atlas, Conch., pl. xiii, fig. 5.
1884. *Textularia sagittula* Brady, Chal. Rept., vol. ix, p. 361, pl. xlii, figs. 17, 18.
1898. *Textularia sagittula* Bagg, Bull. U. S. G. S., No. 88, p. 29.
1898. *Textularia sagittula* Bagg, Bull. Am. Pal., vol. 2, No. 10, p. 314.
1901. *Textularia sagittula* Bagg, Md. Geol. Surv., Eocene, p. 234, pl. 62, fig. 2.
1904. *Textularia sagittula* Bagg, Md. Geol. Surv., Miocene, p. 472, pl. 132, figs. 11–12.

Description.—"Test elongated, strongly compressed, with sharp-angled peripheral margin; chambers numerous (12 to 15),

closely set, visible externally in the upper portion only; septal lines almost straight, curving very gently toward the central portion; aperture linear.

"Length, 0.45–0.55 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, New Egypt, Timber Creek. (Bagg.)

Geographic distribution.—New Jersey; Eocene and Miocene of Maryland.

Textularia turris d'Orbigny.

Plate I., Figs. 18–19.

1840. *Textularia turris* d'Orbigny, Mém. Soc. Géol. France, ser. 1, vol. iv, p. 46, pl. iv, figs. 27, 28.

1884. *Textularia turris* Brady, Chal. Rept., vol. ix, p. 366, pl. xliv, figs. 4, 5.

1898. *Textularia turris* Bagg, Bull. U. S. G. S., No. 88, p. 30.

Description.—"Test nearly round in transverse section, elongate, conical, rugose, tapering, anteriorly truncate; chambers numerous, complanate, somewhat irregular, quite distinct at the distal end.

"Length, 1 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Timber Creek (Bagg).

Geographic distribution.—New Jersey.

Genus VERNEUILINA d'Orbigny.

Verneuilina polystropha (Reuss).

Plate I., Figs. 20–21.

1845. *Bulimina polystropha* Reuss, Verstein. böhm. Kreide, pt. 2, p. 109, pl. xxiv, fig. 53.

1884. *Verneuilina polystropha* Brady, Chal. Rept., vol. ix, p. 386, pl. xlvii, figs. 15–17.

1898. *Verneuilina polystropha* Bagg, Bull. U. S. G. S., No. 88, p. 30.

Description.—"Test arenaceous, rough, somewhat triangular, composed of only a few chambers, which increase very rapidly in

size from below downward; aperture a central arched opening in the ultimate segment.

"Length, 0.43 mm." (Bagg).

Formation and locality.—Navesink marl, Freehold (Bagg).

Geographic distribution.—New Jersey.

Verneuilina triquetra (Münster).

Plate I., Fig. 22.

1838. *Textularia triquetra* Münster, in Rœmer's paper, Neues Jahrb., p. 384, pl. iii, fig. 19.

1851. *Textularia atlantica* Bailey, Smithsonian Contrib., vol. ii, art. 3, p. 12, figs. 38–43.

1884. *Verneuilina triquetra* Brady, Chal. Rept., vol. ix, p. 383, pl. xlvii, figs. 18–20.

1898. *Verneuilina triquetra* Bagg, Bull. U. S. G. S., No. 88, p. 30, pl. 2, fig. 2.

Description.—"Test composed of coarse sand grains and scattered grains of glauconite, triserial; chambers with flattened sides, definitely marked by sutures, eight to ten in each series; transverse section an almost equilateral triangle; surface rugose, and the coarse sand grains are interspersed with grains of glauconite; septal lines arched in the central portion and directed downward toward the edges; triangular edges not always straight, but curved somewhat in passing from the primordial to the distal end; aperture a median elongated slit with a depressed margin.

"The shell is of a dull-gray color, and attains large size.

"An analysis of *Verneuilina triquetra* gave 41.37 per cent. of silica. The sand grains are very firmly cemented by calcareous substance which forms the base of the shell.

"It is a very common species.

"Length, 3.13 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Mullica Hill, Timber Creek (Bagg); Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Genus TRITAXIA Reuss.

Tritaxia tortilis (Reuss).

1861. *Bulimina tortilis* Reuss, Sitz. Akad. Wiss. Wien, vol. xliv, pt. 1, p. 338, pl. viii, fig. 3, a, b.
1898. *Tritaxia tortilis* Bagg, Bull. U. S. G. S., No. 88, p. 31.

Description.—"Test small, trihedral; chambers few, five to seven in each series, somewhat inflated and depressed at the septal lines; peripheral margins rather sharp; primordial end bluntly pointed; ultimate segment large, overreaching, and bearing the elliptical aperture near the upper part of the septal face.

"Length, 0.52 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Swedesboro (Bagg).

Geographic distribution.—New Jersey.

Tritaxia tricarinata (Reuss).

Plate I., Figs. 23–24.

1845. *Textularia tricarinata* Reuss, Verstein. böhm. Kreide, pt. 1, p. 39, pl. viii, fig. 60.
1884. *Tritaxia tricarinata* Brady, Chal. Rept., vol. ix, p. 389, pl. xlix, figs. 8, 9.
1898. *Tritaxia tricarinata* Bagg, Bull. U. S. G. S., No. 88, p. 31.

Description.—"Test tricarinate; lateral surfaces slightly concave, consisting of a few (four or five) rather indistinct segments in each row; aperture central, rotund, in a short elevated neck.

"Length, 1.3 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Swedesboro, Timber Creek (Bagg); Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Genus GAUDRYINA d'Orbigny.

Guadryina pupoides d'Orbigny.

Plate I., Figs. 27–29.

1840. *Gaudryina pupoides* d'Orbigny, Mém. Soc. Géol. France ser. 1, vol. iv, p. 44, pl. iv, figs. 22-24.

1884. *Gaudryina pupoides* Brady, Chal. Rept., vol. ix, p. 378, pl. xlvi, figs. 1-4.

1898. *Gaudryina pupoides* Bagg, Bull. U. S. G. S., No. 88, p. 31.

Description.—"*Gaudryina pupoides* is an easily recognized species. Its dimorphous mode of growth is generally very apparent, and its variability is limited to such features as the number of segments, the relative length and breadth of the test, and the degree of lateral compression. In recent shells the walls are thin and calcareous, smooth externally, and almost invariably of a grayish hue; fossil specimens sometimes exhibit slightly rough exterior. In form and position the aperture resembles that of the typical Textulariæ, but it is often surrounded by a raised tip or border. (Brady.)

"Length, 2 mm."

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Genus CLAVULINA d'Orbigny.

Clavulina communis d'Orbigny.

1826. *Clavulina communis* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 268, No. 4.

1846. *Clavulina communis,* d'Orbigny, Foram. Foss. Bassin tert. Vienne; p. 196, pl. xii, figs. 1, 2.

1898. *Clavulina communis* Bagg, Bull. U. S. G. S., No. 88, p. 32.

Description.—"Test elongate, straight, rough externally and arenaceous; early segments triquetrous, spiral, and forming a pointed apex, a transverse section of which is round, not angular as in *Clavulina parisiensis* d'Orbigny; anterior chambers marked by depressa septa, somewhat irregular in size, but the ultimate one is the largest; aperture normally a central opening in a short tubular neck of the ultimate chamber.

"Length, 2.1 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Brownsville (Bagg).

Geographic distribution.—New Jersey.

Clavulina parisiensis d'Orbigny.

Plate I., Fig. 25.

1826. *Clavulina parisiensis* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 268, No. 3; Modéle, No. 66.

1884. *Clavulina parisiensis* Brady, Chal. Rept., vol. ix, p. 395, pl. xlviii, figs. 14-18.

1898. *Clavulina parisiensis* Bagg, Bull. U. S. G. S., No. 88, p. 32.

Description.—"Test coarsely arenaceous, elongated, straight or nearly so; ultimate chambers nodosarian, short, marked by straight, somewhat depressed septa; primordial segments triquetrous as in *Clavulina communis* d'Orbigny, but wedge-shaped and triangular in outline instead of being rounded; aperture a central opening in a short tubular neck.

"Length, 2.4 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Brownsville (Bagg).

Geographic distribution.—New Jersey.

Sub-family BULIMININÆ.

Genus Bulimina d'Orbigny.

Bulimina puschi Reuss.

1851. *Bulimina puschi* Reuss, Haidinger's Naturw. Abhandl., vol. iv, pt. 1, p. 37, pl. iii, fig. 6.

1898. *Bulimina puschi* Bagg, Bull. U. S. G. S., No. 88, p. 32.

Description.—"Test elongate oval, obtusely rounded above, acutely rounded below, shell wall very punctate; chambers rapidly increasing in size from below upward, irregularly wedge-shaped, moderately depressed at the sutures; aperture a comma-shaped slit near the margin of the ultimate segment.

"Length, 0.5 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg).
Geographic distribution.—New Jersey.

Bulimina variabilis d'Orbigny.

1840. *Bulimina variabilis* d'Orbigny, Mém. Soc. géol. France, ser. 1, vol. iv, pt. 1, p. 40, pl. iv, figs. 9-12.
1845. *Bulimina variabilis* Reuss, Verstein. böhm. Kreide, pt. 1, p. 37, pl. viii, figs. 56, 76, 77.
1898. *Bulimina variabilis* Bagg, Bull. U. S. G. S., No. 88, p. 33.

Description.—"Test variable, ovate or oblong, very finely perforate; spire short, obtuse posteriorly; segments few, very narrow, slightly oblique; ultimate chamber ending in a flat surface; aperture oval, situated at the inner margin.

"Diameter, 0.2-0.3 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg).
Geographic distribution.—New Jersey.

Genus Bolivina d'Orbigny.

Bolivina punctata d'Orbigny.

Plate I., Fig. 26.

1839. *Bolivina punctata* d'Orbigny, Foram. Amér. Merid., p. 63, pl. viii, figs. 10-12.
1846. *Bolivina antiqua* d'Orbigny, Foram. Foss. Bassin tert. Vienne, p. 240, pl. xiv, figs. 11-13.
1857. *Bolivina punctata* Macdonald, Ann. Mag. Nat. Hist., ser. 2, vol. 20, p. 193, pl. vi, figs. 26, 27.
1884. *Bolivina punctata* Brady, Challenger Report, vol. 9, p. 417, pl. lii, figs. 18, 19.
1884. *Bolivina punctata* Woodward and Thomas, Thirteenth Ann. Rept. Geol. Nat. Hist. Survey Minnesota, p. 169, pl. iii, fig. 12.
1895. *Bolivina punctata* Woodward and Thomas, Pal. Minn., vol. 1, p. 34, pl. C, figs. 27-28.
1898. *Bolivina punctata* Bagg, Bull. U. S. Geol. Survey No. 88, p. 33, pl. ii, fig. 3.
1905. *Bolivina punctata* Bagg, Bull. U. S. G. S., No. 268, p. 24, pl. 3, fig. 6.

Description.—"Test elongate, textulariform, smooth, compressed, finely perforate, anterior end obtuse, posterior acute, lateral margins subcarinate; chambers five to seven in each series; septal lines depressed; aperture terminal, simple, oval.

"Length, 0.35 mm.; greatest breadth, 0.15 mm." (Bagg.)

Remarks.—"This species is common at Freehold. It resembles *Bolivina textilaroides* Reuss in the small number of chambers and somewhat broader outline, but differs from this latter species in being much more oval in outline when seen in transverse section." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg); Navesink marl, Freehold, Bruere's pits on Crosswicks Creek (Bagg).

Geographic distribution.—New Jersey, Minnesota, Nebraska; Miocene, California.

Bolivina textilaroides Reuss.

Plate I., Figs. 30–31.

1862. *Bolivina textilaroides* Reuss, 1862, Sitzungsber. K. Akad. Wiss. Wien, vol. 46, p. 81, pl. x, fig. 1.

1880. *Bolivina textularioides* Berthelin, 1880, Mém. Soc. Géol. France, sér. 3, vol. 1, p. 28, pl. 1 (xxiv), fig. 5.

1883. *Bolivina textilarioides* Terrigi, 1883, Atti Accad. Pontificia Nuovi Lincei, vol. 35, p. 191, pl. iii, fig. 32.

1884. *Bolivina textilarioides* Brady, 1884, Challenger Report, vol. 9, p. 419, pl. liii, figs. 23-25.

1888. *Bolivina textilarioides* Brady, Parker, and Jones, 1888, Trans. Zool. Soc., vol. 12, pt. 7, p. 221, pl. xliii, fig. 1.

1895. *Bolivina textularoides* Egger, 1895, Jahrsber. Naturhist. Ver. Passau, vol. 16, p. 12, pl. i, fig. 8.

1898. *Bolivina textilaroides* Bagg, Bull. U. S. G. S., No. 88, p. 34.

1905. *Bolivina textilaroides* Bagg, Bull, U. S. G. S., No. 268, p. 25, pl. 4, fig. 1.

Description.—"Test textulariform; segments few in number, about six in each series; septal lines depressed, and the chambers

somewhat inflated; surface smooth, finely punctate; peripheral margins rounded, and more or less lobulated.

"Length, 1 mm." (Bagg.)

Remarks.—"This species is less common than *Bolivina punctata*" (Bagg).

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg).

Geographic distribution.—New Jersey; Miocene, California.

Genus PLEUROSTOMELLA Reuss.

Pleurostomella subnodosa (Reuss).

Plate I., Figs. 32–34.

1845. *Nodosaria nodosa* (pars) Reuss, Verstein. böhm. Kreide, pt. 1, p. 28, pl. xiii, fig. 22.

1850. *Dentalina subnodosa* (pars) Reuss, Haidinger's Naturw. Abhandl., vol. iv, pt. 1, p. 24, pl. i, fig. 9.

1884. *Pleurostomella subnodosa* Brady, Chal. Rept., vol. ix, p. 412, pl. lii, figs. 12, 13.

1898. *Pleurostomella subnodosa* Bagg, Bull. U. S. G. S., No. 88, p. 34.

Description.—"Test elongate, almost straight, with somewhat irregular outline; chambers enlarging, slightly convex, separated by oblique sutures; ultimate chamber largest, shortly acute; primordial chamber smallest, rounded; aperture an elongated, naked, oval opening extending slightly down the side of the ultimate segment.

"Length, 1 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Timber Creek (Bagg).

Geographic distribution.—New Jersey.

Family LAGENIDÆ.

Sub-family LAGENINÆ.

Genus LAGENA Walker and Boys.

Largena globosa (Montagu).

Plate I., Figs. 35–37.

1803. *Vermiculum globosum* Montagu; Testac. Brit., p. 523.

1851. *Oolina simplex* Reuss, Haidinger's Naturw. Abhandl., vol. iv, pt. 1, p. 22, pl. i, fig. 2.
1857. *Entosolenia globosa* Parker and Jones, Ann. Mag. Nat. Hist., ser. 2, vol. 19, p. 278, pl. 11, figs. 25–29.
1858. *Entosolenia globosa* Williamson, Recent Foram. Great Brit., p. 8, pl. 1, figs. 15–16.
1863. *Lagena globosa* Reuss, Sitz. Akad. Wiss. Wien, vol. xlvi, pt. 1, p. 318, pl. i, figs. 1–3.
1876. *Lagena globosa* Terquem, Anim. Plage Dunkerque (2), p. 67, pl. 7, figs. 3–4.
1884. *Lagena globosa* Brady, Chal. Rept., vol. ix, p. 452, pl. lvi, figs. 1–3.
1898. *Lagena globosa* Bagg, Bull. Am. Pal., vol. 2, No. 10, pp. 317–318.
1898. *Lagena globosa* Bagg, Bull. U. S. G. S., No. 88, p. 34.
1905. *Lagena globosa* Bagg, Bull. U. S. G. S., No. 268, p. 26, pl. 4, fig. 3.

Description.—"Test subglobular, elliptical or pyriform; surface smooth; finely perforate shell with thin, hyaline cell walls; anterior margin somewhat projecting, with aperture in an entorolenian neck.

"Length, 2 mm.; breadth, 1.5 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Mullica Hill (Bagg).

Geographic distribution.—New Jersey; Miocene, California.

Genus VITRIWEBBINA Chapman.

Vitriwebbina sollasi Chapman.

Plate I., Figs. 38–39.

1892. *Vitriwebbina sollasi* Chapman, Geol. Mag., n. s., decade 3, vol. ix, No. 2, Feb., pp. 53–54, pl. ii, figs. 1–3.
1898. *Vitrewebbina sollasi* Bagg, Bull. U. S. G. S., No. 88, p. 35, pl. 2, figs. 5a-b.

Description.—"Test smooth, adherent, hyaline, finely perforate; consisting of one or many chambers arranged in a more or less

curving irregular chain; chambers attached by stoloniferous tubes; aperture terminal in ultimate chamber; length variable, dependent upon the number of chambers.

"Breadth, 0.2–0.6 mm.; shell diameter, 0.01 mm." (Bagg.)

Remarks.—"This is a very common form at Vincentown, and is frequently found adhering to *Flabellina sagittaria,* although often occurring on other shell fragments. Although the primordial chamber is generally the smallest and the ultimate the largest, there is no regularity of arrangement in regard to size of the chambers.

"It was with some difficulty that the position of this form was determined. The structure of the shell substance alone separates it from *Trochammina irregularis* Carpenter,[1] but solution of the shell in hydrochloric acid failed to reveal any trace of arenaceous or siliceous material, although in some cases there was an inner coating of amorphous material remaining insoluble in the acid.

"A form similar to the one under discussion is figured by Quenstedt[2] and described by him as *Bullopora rostrata* in the following words: 'This consists of simple, small, dark hemispheres, united with each other through lengthened tubes. This tube often projects from the end cell like a beak, whence I have given it its name. Generally the pustules (chambers) increase in size, with now and then smaller ones between, while the primordial cell is similar to those succeeding.' This species is described by Schwager[3] as *Placopsilina rostrata,* and is placed under the calcareous perforate division of the Dentaloidea.

"In the original description of the genus Placopsilina[4] no mention is made of the nature of the test, whether of arenaceous or calcareous composition, but later authorities (Brady[5]) consider the genus under arenaceous types of the Lituolidæ.

"The tubulated structure of the genus Webbina, simulating the arenaceous Trochamminæ, is quite striking, and its calcareous

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[1] Introduction to the Study of the Foraminifera, p. 142, Pl. XI, figs. 6-10.

[2] Der Jura, 1858, p. 580, Atlas, Pl. LXXIII, fig. 28.

[3] Bolletino del R. Comitato Geol. d'Italia, 1877, vol. viii, p. 18, Pl. fig. 12.

[4] d'Orbigny, A. D., Prodrome de Paleontologie Stratigraphique, 1850, vol. ii, p. 96.

[5] *Challenger* Report, 1884, vol. ix, p. 314.

composition in this case led to a discussion by Dr. W. J. Sollas,[1] 'On the perforate character of the genus Webbina,' etc., and the later establishment of a new genus, Vitriwebbina, by Frederick Chapman,[2] which I have adopted as a solution of the difficulty presented by this isomorphous form." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Vitriwebbina laevis (Sollas).

Plate I, Figs. 40–41.

1877. *Webbina lævis,* Sollas, Geol. Mag., n. s., decade 2, vol. iv. No. 3, March, pp. 103–104, pl. vi, figs. 1–3.

1892. *Vitriwebbina lævis* Chapman, Geol. Mag., n. s., decade 3, vol. 9, p. 54, pl. 2, fig. 4.

1898. *Vitrewebbina lævis* Bagg, Bull. U. S. G. S., No. 88, p. 36, pl. 2, figs. 4a-b.

Description.—"Test very similar to *Vitriwebbina sollasi* in shape and general appearance, and differing from that species only in having no external marginal flange and in being somewhat more elevated. The form occurs with the preceding in the limesand at Vincentown, but is not very common, while *Vitriwebbina sollasi* is rather plentiful." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Sub-family NODOSARINÆ.

Genus Nodosaria Lamarck.

Nodosaria acuminata (Reuss).

1860. *Dentalina acuminata* Reuss, Sitz. Akad. Wiss. Wien, vol. xl, p. 181, pl. i, fig. 7.

1898. *Nodosaria acuminata* Bagg, Bull. U. S. G. S., No. 88, p. 36.

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[1] Geol. Mag., n. s., decade 2, vol. iv, No. 3, March, 1877, pp. 102–105.

[2] Geol. Mag., n. s., decade 3, vol. ix, No. 2, Feb., 1892, p. 53.

Description.—"Test elongate, straight, tapering sharply; surface smooth; nine oval, regular chambers, rapidly increasing in size toward the distal end; primordial end acuminate; ultimate chamber globose, anteriorly prolonged into a distinct eccentric tube; septa depressed, transverse; aperture nipple-shaped.

"Length, 0.9 mm." (Bagg.)

Remarks.—"The above species is very similar to *Dentalina subrecta* Reuss, but the latter has fewer segments and the proximal end less acuminate." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Nodosaria adolphina (d'Orbigny).

Plate I., Fig. 42.

1846. *Dentalina adolphina* d'Orbigny, Foram. Foss. Bassin tert. Vienne, p. 51, pl. ii, figs. 18–20.

1855. *Dentalina adolphina* Bornemann, Zeitsch. Deutsch. Geol. Gesell., vol. 7, p. 324, pl. 13, fig. 5.

1886. *Dentalina adolphina* Sherborn and Chapman, Jour. Roy. Micros. Soc., ser. 2, vol. vi., p. 750, pl. xv, figs. 11, *a, b,* 12.

1898. *Nodosaria adolphinula* Bagg, Bull. U. S. G. S., No. 88, p. 37.

1900. *Nodosaria adolphina* Chapman, Proc. Cal. Acad. Sci., ser. 3, vol. 1, p. 249, pl. 29, fig. 16.

1905. *Nodosaria adolphina* Bagg, Bull. U. S. G. S., No. 268, p. 28, pl. 5, fig. 1.

Description.—"Test composed of six or seven short, oval chambers, very strongly separated by septal constructions. The anterior portions of the ultimate chambers are smooth, but upon the lower ends of these are two rows of spines or tubercles jutting out at a low angle from the surface. Upon the primordial segments these spines are found to cover the whole surface. Primordial chamber armed with a short spine; ultimate segment ending in a tubular neck, which carries the round aperture.

"Length, 1 mm. and over." (Bagg.)

Remarks.—"This small nodosarian form is not uncommon in the limesand beds below Swedesboro" (Bagg).

Formation and locality.—Vincentown limesand, near Swedesboro (Bagg).

Geographic distribution.—New Jersey; Miocene of California.

Nodosaria annulata Reuss.

1844. *Nodosaria annulata* Reuss, Geogn. Skizze Böhmen, vol. ii, pt. 1, p. 210.

1845. *Nodosaria annulata* Reuss, Verstein. böhm. Kreide, pt. 1, p. 27, pl. viii, figs. 4, 6, 7; pl. xiii, fig. 21.

1898. *Nodosaria annulata* Bagg, Bull. U. S. G. S., No. 88, p. 37.

Description.—"Test smooth and glistening, arcuate, very elongate, tapering sharply to a point toward the proximal end; chambers spherical, numerous, fifteen to twenty, more constricted and globose toward the ultimate chamber, which is prolonged somewhat in its upper portion and carries the round mammillate aperture; septa transverse, definitely depressed at the anterior end.

"Length, over 10 mm. in long specimens; breadth of largest chamber, 1 mm." (Bagg.)

Remarks.—"This is one of the largest of all our nodosarian types. It resembles the specimens of *Nodosaria obliqua*, but is easily distinguished from the latter by its smooth surface. The proximal end of the shell sometimes shows very faint striæ as indications of ribs, but these are never prominent, and are visible only under the microscope." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg); Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Nodosaria communis (d'Orbigny.)

Plate I., Figs. 43–44.

1826. *Dentalina communis* d'Orbigny, Annales Sciences Naturelles, vol. 7, p. 254, No. 35.

1840. *Dentalina communis* d'Orbigny, Mém. Soc. Géol. France, vol. 4, p. 13, pl. i, fig. 4.

1845. *Nodosaria communis* Reuss, Verstein. böhm. Kreid., pt. 1, p. 28, pl. xii, fig. 21.
1860. *Dentalina communis* Reuss, Sitzungsber. K. Akad. Wiss. Wien, vol. 40, p. 186.
1860. *Dentalina legumen* Reuss, Sitzungsber. K. Akad. Wiss. Wien, vol. 40, p. 186.
1860. *Dentalina communis* Jones and Parker, Quart. Jour. Geol. Soc. Lond., vol. 16, p. 453, pl. 19, figs. 25-26.
1884. *Nodosaria communis* Brady, Challenger Report, vol. 9, pp. 504, 505, pl. lxii, figs. 19–22.
1895. *Nodosaria communis* Egger, Jahrsber. Naturhist. Ver. Passau, vol. 16, p. 20, pl. ii, figs. 1, 2.
1898. *Nodosaria communis* Bagg, Bull. U. S. G. S., No. 88, p. 37.
1898. *Nodosaria communis* Bagg, Bull. Am. Pal., vol. 2, No. 10, p. 319.
1901. *Nodosaria communis* Bagg, Md. Geol. Surv., Eocene, p. 237, pl. 62, fig. 7.
1905. *Nodosaria communis* Bagg, Bull. U. S. G. S., No. 268, p. 29, pl. 5, fig. 2.

Description.—"Test elongate, slightly arcuate, smooth; septa oblique, depressed; chambers numerous, ten to fifteen, convex anteriorly; aperture small, radiate, situated near the incurved margin.

"Length 3.26 mm." (Bagg.)

Formation and locality.—Navesink marl, Cream Ridge, Bruere's pits on Crosswicks Creek (Bagg); Vincentown lime-sand, New Egypt, Mullica Hill, Timber Creek (Bagg).

Geographic distribution.—New Jersey; Eocene of Maryland; Miocene of California.

Nodosaria consobrina (d'Orbigny).

Plate I., Figs. 48–49.

1846. *Dentalina consobrina* d'Orbigny, Foram. Foss. Bassin tert. Vienne, p. 46, pl. ii, figs. 1–3.
1856. *Dentalina consobrina* Neugeboren, Denkschr. K. Akad. Wiss. Wien, vol. 12, p. 86, pl. 3, fig. 15.

1884. *Nodosaria consobrina* Brady, Chal. Rept., vol. ix, p. 501, pl. lxii, figs. 23, 24.

1898. *Nodosaria consobrina* Bagg, Bull. U. S. G. S., No. 88, p. 38.

1905. *Nodosaria consobrina* Bagg, Bull. U. S. G. S., No. 268, p. 29, pl. 5, fig. 3.

Description.—"Test smooth, dentaline, attenuated, and graceful; chambers nine or ten, shorter and less distinct at the proximal end, but becoming more definite above and more elongated; septa distinct, straight, or nearly so, becoming more marked in the proximal extremity; ultimate chamber somewhat prolonged into a neck which carries the oral aperture; proximal end very neatly rounded.

"Length, 2 mm." (Bagg.)

Remarks.—"This slender little species is very closely allied to the emaciate variety found in the Hornerstown marl beds, but it is not so elongated and has a much smaller number of chambers." (Bagg.)

Formation and locality.—Marshalltown clay marl, Marshalltown (Bagg).

Geographic distribution.—New Jersey; Miocene of California.

Nodosaria consobrina var. emaciata (Reuss).

Plate I., Figs. 45–46.

1851. *Dentalina emaciata* Reuss, Zeitschr. Deutsch, Geol. Gesell., vol. 3, p. 63, pl. 3, fig. 9.

1865. *Nodosaria* (D.) *consobrina,* var. *emaciata,* Reuss, Denks. Akad. Wiss. Wien, Vol. xxv, p. 132, pl. ii, figs. 12, 13.

1884. *Nodosaria* (D.) *consobrina,* var. *emaciata,* Brady, Chal. Rept., vol ix, p. 502, pl. lxii, figs. 25, 26.

1898. *Nodosaria consobrina* var. *emaciata* Bagg, Bull. U. S. G. S., No. 88, p. 38.

1898. *Nodosaria consobrina* var. *emaciata* Bagg, Bull. Am. Pal., vol. 2, No. 10, p. 319.

1901. *Nodosaria consobrina* var. *emaciata* Bagg, Md. Geol. Surv., Eocene, p. 238, pl. 62, fig. 8.

1905. *Nodosaria consobrina* var. *emaciata* Bagg, Bull. U. S. G. S., No. 268, p. 30, pl. 5, fig. 4.

Description.—"Test smooth, greatly elongated, tapering; segments numerous, short, elongate oval; similar to *Nodosaria consobrina,* but more elongated and slender; septa somewhat depressed, transverse, primordial end rounded; aperture mammillate, somewhat prolonged into a tube.

"Length, 2 mm." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg); Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey; Eocene of Maryland, Miocene of California.

Nodosaria farcimen (Soldani).

Plate I., Fig. 50.

1791. *Orthoceras farcimen* Soldani, Testaceographia, vol. 1, pt. 2, p. 98, pl. cv, fig. o.

1861. *Dentalina farcimen* Reuss, Bull. Acad. Roy. Belgique, sér. 2, vol. 15, p. 146, pl. i, fig. 18.

1884. *Nodosaria farcimen* Brady, Challenger Report, vol. 9, pp. 498, 499, pl. lxii, figs. 17, 18, and woodcuts, p. 499.

1898. *Nodosaria farcimen* Bagg, Bull. U. S. Geol. Survey No. 88, pp. 38, 39.

1898. *Nodosaria farcimen* Bagg, Bull. American Paleont., vol. 2, No. 10, pp. 25, 26, pl. i, fig. 2.

1900. *Nodosaria farcimen* Chapman, Proc. California Acad. Sci., ser. 3, vol. 1, No. 8, p. 248, pl. xxix, fig. 13.

1905. *Nodosaria farcimen* Bagg, Bull. U. S. G. S., No. 268, p. 30, pl. 5, fig. 5.

Description.—"Test arcuate, tapering, with from six to ten inflated segments, separated by deep, straight, transverse sutures. The latter quality separates this species from *Nodosaria communis,* in which the sutures are oblique. There is also an irregularity in the increase of the size of the chambers noticeable in most specimens. The ultimate chamber is prolonged into a round tube which bears the oral opening.

"Length, 2.82 mm." (Bagg.)

Formation and locality.—Vincentown limesand, New Egypt (Bagg).

Geographic distribution.—New Jersey; Eocene of Virginia, Miocene of California.

Nodosaria filiformis d'Orbigny.

Plate I., Fig. 47.

1826. *Nodosaria filiformis* d'Orbigny, Ann. Sci. Natur., vol. vii, p. 253, No. 14.

1840. *Dentalina gracilis* d'Orbigny, Mém. Soc. Géol. France, ser. 1, vol. iv, p. 14, pl. i, fig. 5.

1884. *Nodosaria filiformis* Brady, Chal. Rept., vol. ix, p. 500, pl. lxiii, figs. 3-5.

1898. *Nodosaria filiformis* Bagg, Bull. U. S. G. S., No. 88, p. 39.

1905. *Nodosaria filiformis* Bagg, Bull. U. S. G. S., No. 268, p. 31, pl. 5, fig. 6.

Description.—"Test slender, elongated, smooth, crenate; chambers numerous (12), distinct, elongate oval; septa transverse, nonoblique; aperture simple, round.

"Length, 2.1 mm." (Bagg.)

Formation and locality.—Navesink marl, Cream Ridge (Bagg); Red Bank sand, Red Bank (Bagg); Vincentown limesand, Mullica Hill, Timber Creek (Bagg).

Geographic distribution.—New Jersey; Miocene of California.

Nodosaria indifferens (Reuss).

1863. *Dentalina indifferens* Reuss, Sitz. Akad. Wiss. Wien, vol. xlviii, pt. 1, p. 44, pl. ii, figs. 15, 16.

1898. *Nodosaria indifferens* Bagg, Bull. U. S. G. S., No. 88, p. 39.

Description.—"Test consisting of from six to eight smooth, short, inflated chambers of unequal size; primordial chamber larger than the succeeding one, obtusely rounded; ultimate chamber large and more constricted than any of the other chambers.

"Length, 1.7 mm." (Bagg.)

Formation and locality.—Navesink marl, Cream Ridge (Bagg).

Geographic distribution.—New Jersey.

Nodosaria inornata (d'Orbigny).

1846. *Dentalina inornata* d'Orbigny, Foram. Foss. Bassin tert. Vienne, p. 44, pl. i, figs. 50, 51.
1886. *Dentalina inornata* Sherborn and Chapman, Jour. Roy. Microsc. Soc., ser. 2, vol. vi, pt. 2, p. 750, pl. xv, fig. 8.
1898. *Nodosaria inornata* Bagg, Bull. U. S. G. S., No. 88, p. 39.

Description.—"Test smooth, gently tapering, with chambers distinct and more indented upon one side than upon the other; septa very oblique, and curving very slightly in the central, and more markedly so near the margin of the lowest end of each chamber; aperture nearer one side.

"Only three segments preserved.

"Length unknown." (Bagg.)

Remarks.—"The New Jersey specimens are almost identical with the form figured by Sherborn and Chapman from the London clay of England.

"According to Professor Brady, this species is considered to be identical with *Nodosaria communis* d'Orbigny, and is given by him as a synonym under that name, but it is here kept distinct for several reasons, as it is by Chapman and Sherborn." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg).

Geographic distribution.—New Jersey.

Nodosaria laevigata d'Orbigny.

Plate I., Figs. 51–54.

1826. *Nodosaria (Glandulina) lævigata* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 252, pl. x, figs. 1-3.
1846. *Glandulina lævigata* d'Orbigny, Foram. Foss. Bassin tert. Vienne, p. 29, pl. i, figs. 4, 5.

1884. *Nodosaria lævigata* Brady, Chal. Rept., vol. ix, pp. 490, 493, pl. lxi, figs. 17-22, 32.
1898. *Nodosaria lævigata* Bagg, Bull. U. S. G. S., No. 88, p. 40.

Description.—"Test cylindrical, tapering rapidly to a point at the primordial chamber; shell smooth, consisting of five or six short, indistinct segments; septal lines transverse; aperture round, crenulate.

"Length, 0.65 mm." (Bagg.)

Remarks.—"This small species occurs sparingly in the limesand at Vincentown. The American specimens are very similar to the forms from Germany figured by Professor Reuss under the name *Glandulina elliptica*.[1]" (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Nodosaria longiscata d'Orbigny.

1846. *Nodosaria longiscata* d'Orbigny, Foram. Foss. Bassin tert. Vienne, p. 32, pl. i, figs. 10-12.
1898. *Nodosaria longiscata* Bagg, Bull. U. S. G. S., No. 88, p. 40.

Description.—"Test elongate, smooth, consisting of chambers greatly extended and united end to end by definite constrictions. The forms are never found of full length, owing to the weak jointing of the segments, which allows them to break apart very readily. The species is somewhat similar to *Nodosaria ovulata* Sherborn and Chapman, but the chambers are not angular at their base, as in the latter species.

"Length unknown." (Bagg.)

Formation and locality.—Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey.

[1] Sitz. Akad. Wiss. Wein, 1863, vol. xlviii, p. 47, pl. iii, figs. 29–31.

Nodosaria multicostata (d'Orbigny).

1840. *Dentalina multicostata* d'Orbigny, Mém. Soc. géol. France, ser. 1, vol. iv, p. 15, pl. i, figs. 14, 15.
1898. *Nodosaria multicostata* Bagg, Bull. U. S. G. S., No. 88, p. 40.

Description.—"Test large, abruptly tapering, arcuate; surface marked by numerous (24 at the anterior end) sharp, distinct, longitudinal costæ, slightly twisted and irregular in their arrangement; chambers nine or ten, short, deeply constricted, becoming more distinct toward the proximal end; aperture small, rotund, ending in a definitely constricted neck surrounded by a crenulated margin.

"Length, 4-5 mm." (Bagg.)

Formation and locality.—Hornerstown marl, Blue Ball (Bagg).

Geographic distribution.—New Jersey.

Nodosaria nitida d'Orbigny.

Plate II., Fig. 14.

1826. *Nodosaria nitida* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 254, No. 33.
1871. *Nodosaria nitida* Parker, Jones, and Brady, Ann. Nat. Hist., ser 4, vol. viii, p. 158, pl. ix, fig. 44.
1876. *Nodosaria nitida* Tate and Blake, Yorkshire Lias, p. 457, pl. xvii, fig. 19.
1898. *Nodosaria nitida* Bagg, Bull. U. S. G. S., No. 88, p. 41.

Description.—"A small striate Nodosaria, deeply constricted at its septa and having few, distinct, oval, or fusiform segments. A less robust form than *Nodosaria scalaria*, and less neatly finished as to base and terminal neck than that species generally is." (Parker, Jones and Brady.)

"Length (of the three ultimate segments), 2.82 mm." (Bagg.)

Remarks.—"Owing to the deep constrictions, this form is easily broken, and I have no specimens with more than three

segments. The ribs are very distinct and elevated, and there are small intermediate striæ between some, but not all, of the main costæ. The aperture ends in a phialine neck." (Bagg.)

Formation and locality.—Hornerstown marl, Blue Ball (Bagg).

Geographic distribution.—New Jersey.

Nodosaria obliqua (Linné).

Plate II., Figs. 12–13.

1767. *Nautilus obliquus* Linné, Syst. Nat., twelfth ed., pp. 281, 1163; 1788, ibid., thirteenth (Gmelins) ed., p. 3372, No. 14.

1822. *Orthocera obliqua* Lamark, Anim. sans Vert., vol. 7, No. 4, p. 594.

1827. *Nodosaria sulcata* Nilsson, Petrefacta Suec., p. 8, pl. ix, fig. 19.

1840. *Dentalina sulcata* d'Orbigny, Mém. Soc. géol. France, ser. 1, vol. iv, p. 15, pl. i, figs. 10-13.

1855. *Dentalina steenstrupi* Reuss, Zeits. deutsch. geol. Gesell., vol. vii, p. 268, pl. viii, fig. 14a.

1855. *Dentalina sulcata* Reuss; ibid., p. 269, pl. viii, fig. 14b.

1866. *Dentalina obliqua* Jones, Parker, and Brady, Monograph Foram. Crag, Pal. Soc. vol. xix, p. 54, pl. i, fig. 9.

1884. *Nodosaria obliqua* Brady, Chal. Rept., vol. 9, pp. 513, 514, pl. 64, figs. 20-22.

1898. *Nodosaria obliqua* Bagg, Bull. U. S. G. S., No. 88, p. 41.

1898. *Nodosaria obliqua* Bagg, Bull. Amer. Pal., vol. 2, No. 10, p. 26 (320).

1900. *Nodosaria obliqua* Chapman, Proc. Cal. Acad. Sci., ser. 3, vol. 1, No. 8, p. 249, pl. 29, fig. 17.

1901. *Nodosaria obliqua* Bagg, Md. Geol. Surv., Eocene, p. 239, pl. 62, fig. 10.

1905. *Nodosaria obliqua* Bagg, Bull. U. S. G. S., No. 268, p. 31, pl. 5, fig. 7.

Description.—"Test very large, elongated, arcuate, tapering; septal lines depressed; numerous costæ upon the surface, which vary in size and number in different specimens; chambers nu-

merous, ventricose, distinct; aperture central, radiate. Some specimens end in a spine at the distal end.

"Length, 2-13.5 mm." (Bagg.)

Remarks.—"This species is very common in the New Jersey marl beds and is one of the few forms which are found in all the horizons of the Upper Cretaceous series." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg); Navesink marl, Freehold (Bagg); Hornerstown marl, Blue Ball (Bagg); Vincentown limesand, Vincentown, Mullica Hill, Timber Creek, Harrisonville, New Egypt (Bagg); Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey; Eocene of Maryland and Virginia, Miocene of California.

Nodosaria pauperata (d'Orbigny).

Plate II., Figs. 6-8.

1846. *Dentalina pauperata* d'Orbigny, Foram. Foss. Bassin Tert. Vienne, p. 46, pl. i, figs. 57, 58.

1855. *Dentalina pauperata* Bornemann, Zeitschr. Deutsch. Geol. Gesell., vol. 7, p. 324, pl. xiii, fig. 7.

1860. *Dentalina pauperata* Jones and Parker, Quart. Journ. Geol. Soc. London, vol. 16, p. 453, pl. xix, fig. 22.

1884. *Nodosaria pauperata* Brady, Challenger Report, vol. 9, p. 500, woodcuts fig. 14a, b, c.

1886. *Dentalina pauperata* Sherborn and Chapman, Jour. Roy. Microsc. Soc., ser. 2, vol. 6, p. 750, pl. xv, fig. 9.

1896. *Nodosaria pauperata* Jones, Mon. Foram. Crag, pt. 3, pp. 224-226, pl. i, figs. 13-18, 20.

1898. *Nodosaria pauperata* Bagg, Bull. U. S. Geol. Survey No. 88, p. 42.

1900. *Nodosaria pauperata* Chapman, Proc. California Acad. Sci., ser. 3, vol. 1, No. 8, p. 247, pl. xxix, fig. 12.

1905. *Nodosaria pauperata* Bagg, Bull. U. S. G. S., No. 268, p. 32, pl. 5, fig. 8.

Description.—"Test smooth, somewhat arcuate, tapering very gradually; chambers quite uniform in size, ten or eleven in num-

ber, not constricted in the lower portion of the shell, but becoming distinct and more constricted as they approach the proximal end; ultimate segment prolonged, provided with a constricted tube-like neck which carries the round aperture.

"Length, 2-3 mm." (Bagg.)

Formation and locality. — Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey; Miocene of California.

Nodosaria polygona Reuss.

Plate II., Figs. 9–11.

1855. *Nodosaria polygona* Reuss, Zeits. Deutsch. Geol. Gesell., p. 265, pl. viii, figs. 7, 8.

1898. *Nodosaria polygona* Bagg, Bull. U. S. G. S., No. 88, p. 42.

Description.—"Test cylindrical, elongate, costate, tapering very gradually, straight or but slightly curved; chambers numerous, ten to sixteen, becoming more constricted and globose toward the ultimate segment; primordial chamber larger than the one succeeding, bulbous, mucronate; ultimate chamber terminates in a short tubular neck, in which the round oral aperture is situated; longitudinal costæ few in number, eight to ten, very distinct, and elevated and extending from end to end.

"Length, sometimes 9 mm." (Bagg.)

Remarks.—"The specimens from the Marshalltown marl beds are small (1.1 mm. in length), and have only six chambers, and are rare, while the Vincentown limesand forms are very numerous and are among the largest of the Nodosariæ from New Jersey." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg); Navesink marl, Freehold (Bagg); Hornerstown marl, Blue Ball (Bagg); Vincentown limesand, New Egypt, Harrisonville (Bagg); Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Nodosaria radicula (Linné).

Plate II., Fig. 5.

1767. *Nautilus radicula* Linné, Syst. Nat., 12th ed., pp. 285, 1164; 1788; Gmelin's ed., vol. 1, pt. 6, p. 3373, No. 18.
1803. *Nautilus radicula* Montagu, Test. Brit., p. 197, pl. vi, fig. 4.
1826. *Nodosaria radicula* d'Orbigny, Annales Sciences Naturelles, vol. 7, p. 252, No. 3, Modèle No. 1.
1876. *Nodosaria radicula* Brady, Palæont. Soc., vol. 30, p. 124, pl. 10, figs. 6-16.
1884. *Nodosaria radicula* Brady, Challenger Report, vol. 9, p. 495, pl. lxi, figs, 28-31.
1888. *Nodosaria radicula* Agassiz, Three Cruises "Blake," vol. 2, p. 166, fig. 504.
1898. *Nodosaria radicula* Bagg, Bull. U. S. Geol. Survey No. 88, p. 42.
1900. *Nodosaria radicula* Chapman, Proc. California Acad. Sci. ser. 3, vol. 1, No. 8, p. 247, pl. xxix, fig. 11.
1905. *Nodosaria radicula* Bagg, Bull. U. S. G. S., No. 268, p. 32, pl. 5, fig. 9.

Description.—"Test straight, elongated, tapering, composed of from four to seven subglobose segments; surface of shell smooth; septal lines transverse, depressed; aperture a nipple-shaped protuberance on the ultimate segment.

"Length, 2 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Timber Creek (Bagg).

Geographic distribution.—New Jersey; Miocene of California.

Nodosaria raphanus (Linné).

Plate II., Figs. 3-4.

1767. *Nautilus raphanus* Linné, Syst. Nat., twelfth ed., pp. 283, 1164; 1788, ibid., thirteenth (Gmelin's) ed., p. 3373, No. 16.
1872. *Nodosaria raphanus* Silvestri, Nodos. Fos. Viv. d'Italia, p. 43, pl. iv, figs. 67-81.

1884. *Nodosaria raphanus* Brady, Chal. Rept., vol. ix, p. 512, pl. lxiv, figs. 6-10.
1898. *Nodosaria raphanus* Bagg, Bull. U. S. G. S., No. 88, p. 43.

Description.—"Test elongate, straight, somewhat tapering, stoutly built; surface marked by eight sharp, elevated, distinct costæ; chambers few in number, generally fewer than ten, not very distinct, since the septal lines are nonlimbate; aperture a semilunar arch, median, surrounded by a thickened border.

"Length, 1 mm." (Bagg.)

Formation and locality—Vincentown limesand, southeast of Swedesboro, Timber Creek (Bagg).

Geographic distribution.—New Jersey.

Nodosaria roemeri (Neugeboren).

Plate II., Figs. 1–2.

1856. *Dentalina roemeri* Neugeboren, Denks. Akad. Wiss. Wien., vol. xii, pt. 2, p. 82, pl. ii, figs. 13-17.
1870. *Nodosaria roemeri* Reuss, Sitzungsber. K. Akad. Wiss. Wein, vol. 62, p. 475.
1870. *Nodosaria roemeri* Schlicht, Foram. Pietzpuhl., pl. 10, figs. 21, 22, 24.
1884. *Nodosaria roemeri,* Brady, Chal. Rept., vol. 9, p. 505, pl. 63, fig. 1.
1898. *Nodosaria roemeri* Bagg, Bull. U. S. G. S., No. 88, p. 43.
1905. *Nodosaria roemeri* Bagg, Bull. U. S. G. S., No. 268, p. 33, pl. 5, fig. 10.

Description.—"Test smooth, consisting of six or seven large chambers separated by nearly straight, slightly depressed sutures; primordial chamber rounded and rather blunt; ultimate chamber carrying the oral aperture nearer the incurved margin. Some specimens are slightly curved, but the curvature is never very great.

"Length, 0.82 mm." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg).

Geographic distribution.—New Jersey; Miocene of California.

Nodosaria rotundata (Reuss).

1850. *Glandulina rotundata* Reuss, Denks. Akad. Wiss. Wien., vol. i, p. 366, pl. xlvi, fig. 2.

1863. *Glandulina obtussima* Reuss, Sitz. Akad. Wiss. Wien., vol. xlviii, pt. 1, p. 66, pl. viii, figs. 92, 93.

1898. *Nodosaria rotundata* Bagg, Bull. U. S. G. S., No. 88, p. 43.

Description.—"Test oval, not much elongated, with rounded base, consisting of only two or three segments, usually two, of which the ultimate chamber is much the largest; surface of shell smooth and white; aperture small, rotund, crenulate, placed centrally in ultimate chamber.

"Length, 1-3 mm." (Bagg.)

Remarks.—"This is not an uncommon form in the limesand at Vincentown. Our specimens agree very closely with those figured by Professor Reuss." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Nodosaria scabra (Reuss).

1850. *Dentalina scabra Reuss,* Denk. Akad. Wiss. Wien, vol. i, p. 367, pl. xlvi, figs. 7, 8.

1898. *Nodosaria scabra* Bagg, Bull. U. S. G. S., No. 88, p. 43.

Description.—"Test small, elongate, tapering; surface uniformly covered with raised longitudinal striæ, or tubercles, visible only under high power in reflected light; chambers eight in number, strongly constricted, becoming quite spheroid in the upper portion; primordial chamber furnished with a long, delicate spine upon the inside edge of the line of flexure; ultimate chamber prolonged into a round phialine neck; aperture rotund.

"Length, 1 mm." (Bagg.)

Remarks.—"Reuss describes this form as being very variable in character, and states that there are two extreme types, which would be considered distinct species were it not for the connecting forms. It is a rare species at Vincentown, and we can not state whether the American type is constant or not. The one described agrees very closely with Professor Reuss's figure." (Bagg.)

Formation and locality.—Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Nodosaria spinulosa (Montagu).

1808. *Nautilus spinulosus* Montagu, Test. Brit. Suppl., p. 86, pl. xix, fig. 5.

1886. *Dentalina spinulosa* Sherborn and Chapman, Jour. Roy. Microsc. Soc., ser. 2, vol. vi, p. 751, pl. xv, fig. 13.

1898. *Nodosaria spinulosa* Bagg, Bull. U. S. G. S., No. 88, p. 44.

Description.—"Test slightly arcuate, elongate; surface marked by elevated rib-like spines, which cover the segments irregularly. These rib-like projections jut out prominently, especially on the posterior portion of each segment. Chambers somewhat constricted, ten or more in number on long specimens.

"Length, 2.16 mm." (Bagg.)

Remarks.—The specimens described by Professors Chapman and Sherborn were from the London clay.

Formation and locality.—Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Nodosaria vertebralis (Batsch).

1791. *Nautilus* (*Orthoceras*) *vertebralis* Batsch, Conch. Seasands, p. 3, No. 6, pl. ii, fig. 6, b.

1886. *Dentalina vertebralis* Sherborn and Chapman, Jour. Roy. Microsc. Soc., ser. 2, vol. vi, p. 752, pl. xiv, fig. 39, *a*, *b*.

1898. *Nodosaria vertebralis* Bagg, Bull. U. S. G. S., No. 88, p. 44.

Description.—"Test long, nearly straight; surface marked by slightly elevated longitudinal costæ, very slightly twisted; chambers eight in number, of uniform size, but tapering somewhat toward the primordial segment, unconstricted and marked by rather wide, straight transverse septa; aperture central, mammillate.

"Length, 2.4 mm." (Bagg.)

Remarks.—"Dr. Anthony Woodward describes this species from Stratton's marl pit, near Mullica Hill, where it occurs in the shell layer of the green marl, and also from Timber Creek, in the lime-sand bed; but it is not a common form in either locality." (Bagg.)

Formation and locality.—Vincentown limesand, New Egypt (Bagg).

Geographic distribution.—New Jersey.

Nodosaria williamsi Bagg.

Plate II., Figs. 15–16.

1895. *Nodosaria williamsi* Bagg, Johns Hopkins Univ. Circulars, No. 121, pp. 11-12.

1898. *Nodosaria williamsi* Bagg, Bull. U. S. G. S., No. 88, p. 45, pl. 3, figs. 2a-b.

Description.—"Test small, oval or elliptical, similar to *Nodosaria comata* Batsch, but differing from that species in the arrangement of the costæ, which in our specimens extend the entire length of the shell, while in the former species the oral end is smooth. The costæ are very numerous, fine; chambers three or four, large, inflated, scarcely discernible by the transverse septa; unconstricted at the septal nodes; ultimate chamber truncate; aperture very large, rotund.

"Length, 1.13 mm." (Bagg.)

Formation and locality.—Vincentown limesand, southeast of Swedesboro (Bagg).

Geographic distribution.—New Jersey.

Nodosaria zippei Reuss.

Plate II., Fig. 24.

1844. *Nodosaria zippei* Reuss, Geogn. Skizze Böhm, vol. ii, pt. 1, p. 210.

1845. *Nodosaria zippei* Reuss, Verstein. böhm. Kreide, pt. 1, p. 25, pl. viii, figs. 1-3.

1860. *Dentalina pulchra* Gabb, Jour. Acad. Nat. Sci., Philadelphia, n. s., vol. iv, p. 402, pl. lxix, figs. 40, 41.

1894. *Nodosaria raphanistrum* Woodward, Jour. N. Y. Microsc. Soc., vol. x, No. 4, p. 110.

1898. *Nodosaria zippei* Bagg, Bull. U. S. G. S., No. 88, p. 45, pl. 3, fig. 1.

Description.—"Test straight, or but slightly arcuate, very large and long, sometimes reaching 10 millimeters in length; chambers numerous, becoming more distinct toward the ultimate chamber; primordial segment slightly larger than the one succeeding, mucronate; surface of shell marked by from seven to fourteen (usually about twelve) very prominent costæ, only part of which extend the whole length of the shell; ultimate chamber slightly prolonged; aperture rotund.

"Length, 9 mm. and over. Small specimens, 3.2 mm.; breadth, 0.5–1 mm." (Bagg.)

Remarks.—"This beautiful species is one of the very largest forms of Foraminifera found in the New Jersey Cretaceous marl beds, and was described by Gabb as early as 1860, under the name *Dentalina pulchra*. Owing to its great length it is very easily broken, so that only a few of the largest specimens are perfect. It was very well described by Reuss in 1844 (loc. cit.), who said that its length was sometimes 1½ inches, the number of chambers twenty to thirty, the costæ seven to fourteen, and that there were secondary riblets occasionally set in between the main costæ and running a short distance along the surface of the shell.

"Reuss also pointed out the similarity of *Nodosaria septemcostata* and *N. undecimcostata* Geinitz, and considered the two latter as identical with *N. zippei*. Dr. Anthony Woodward con-

siders this species identical with *N. raphanistrum,* but the two species are sufficiently distinct to justify the retention of the original name given by Professor Reuss.

"This species has a very wide geological range and distribution in the Cretaceous, and occurs in every marl bed of New Jersey.

"In the large amount of material examined in the preparation of this report an interesting case of dimorphism was observed in one of the specimens of *Nodosaria zippei.* The shell which has been previously referred to begins as a textularian with two chambers side by side, each bearing the same number of costæ as the original form and united above into a straight typical nodosarian chamber. It was found in the green marl of Blue Ball, where the Nodosariæ are so perfectly preserved that mucronate forms still retain their spines in almost perfect condition." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg); Navesink marl, Freehold (Bagg); Hornerstown marl, Blue Ball; Vincentown limesand, Vincentown, Harrisonville, etc. (Bagg); Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Genus LINGULINA d'Orbigny.

Lingulina carinata d'Orbigny.

Plate II., Figs. 25–26.

1826. *Lingulina carinata* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 257, No. 1.
1884. *Lingulina carinata* Brady, Chal. Rept., vol. ix, p. 517, pl. lxv, fig. 16, 17.
1898. *Lingulina carinata* Bagg, Bull. U. S. G. S., No. 88, p. 46.

Description.—"Test elliptical, elongate, laterally compressed; surface smooth and glistening; shell consisting of six somewhat extended chambers, separated by arched septa; peripheral margin obtusely angular; chambers increasing rapidly in size toward the distal end and marked by distinct transverse septal lines; primordial chamber circular, not elevated; aperture a narrow terminal slit.

"Length, 1.2–1.85 mm.; breadth, 1–1.3 mm." (Bagg.)

Remarks.—"This beautiful little species is common in the limesand at Vincentown. It resembles *Lingulina bohemica* Reuss both in its lateral compression and in its external form, but is distinguished from that form by its broader elliptical outline and in having invariably six chambers instead of five." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Genus Frondicularia Defrance.

Frondicularia alata d'Orbigny.

Plate II., Figs. 17–19.

1826. *Frondicularia alata* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 256, No. 2.

1884. *Frondicularia alata* Brady, Chal. Rept., vol. ix, p. 522, pl. lxv, figs. 20-23; pl. lxvi, figs. 3-5.

1898. *Frondicularia alata* Bagg, Bull. U. S. G. S., No. 88, p. 46.

Description.—"Test broadly oval, large, complanate; surface smooth, marked by fairly distinct septal lines; chambers narrow, numerous, arched; primordial segment oval, elevated, situated a little within the periphery; basal portion of shell more or less covered by spinous projections, which are either single or united.

"Length, 4.34 mm.; breadth, 3 mm." (Bagg.)

Remarks.—"This form is rather common in many localities where the limesand is developed." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Brownsville, etc. (Bagg).

Geographic distribution.—New Jersey.

Frondicularia angusta (Nillson) var. dimidia Bagg.

Plate II., Figs. 20–21.

1827. *Planularia angusta* Nilsson, Petref. Suec, p. 11, pl. ix, fig. 22 a, A.

1845. *Frondicularia angusta* Reuss, Verstein, böhm. Kreide, pt. 1, p. 29, pl. viii, figs. 13, 14.

1898. *Frondicularia angusta* var. *dimidia* Bagg, Bull. U. S. G. S., No. 88, p. 47, pl. 3, fig. 7 a-b.

Description.—"Test lanceolate, very elongate, strongly compressed and leaf-like; consisting of from ten to twelve chambers, which gradually increase in size toward the proximal end, where the greatest breadth occurs; primordial chamber spherical, elevated, mucronate, and the surface marked by three sharply defined ribs; surface of shell marked by numerous fine longitudinal lines, running nearly parallel to the lateral edges; septa distinct, slightly raised externally as ridges; aperture normally round, terminal.

"Length, 2.6 mm.; breadth, 1 mm.

Remarks.—"This species is very closely allied to the European forms, but differs principally in the number of chambers, which is invariably less than one-half of those of the former type. It is common in the limesand at Vincentown." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Frondicularia archiaciana d'Orbigny, **var. strigillata** Bagg.

Plate II., Fig. 22.

1840. *Frondicularia archiaciana* d'Orbigny, Mém. Soc. géol. France, ser. 1, vol. iv, p. 20, pl. i, figs. 34-36.

1884. *Frondicularia archiaciana* Brady, Chal. Rept., vol. ix, p. 520, pl. cxiv, fig. 12.

1898. *Frondicularia archiaciana* var. *strigillata* Bagg, Bull. U. S. G. S., No. 88, p. 47, pl. 3, fig. 5.

Description.—"Test elongate, complanate, anteriorly acute, posteriorly obtuse, and provided with a short spine; chambers, six to eight, relatively large, equally compressed, and slightly limbate at the lateral edges; surface marked by definite elevated striæ, of which the two central rows are more prominent than those near the margin; primordial chamber globular; ultimate chamber prolonged, tube-like; aperture small, rotund.

"Length, 1.6 mm.; breadth, 0.6 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Frondicularia clarki Bagg.

Plate II., Fig. 23.

1895. *Frondicularia clarki* Bagg, Johns Hopkins Univ. Circulars No. 121, p. 11.

1898. *Frondicularia clarki* Bagg, Bull. U. S. G. S., No. 88, p. 48, pl. 3, fig. 4.

Description.—"Test complanate, smooth, very elongate, oval in outline; consisting of from 12 to 14 narrow parallel chambers; primordial chamber bulbous, elevated, costate, mucronate; ultimate chamber elongate, bearing upon one surface a hollow, somewhat extended tube, which forms an elevated median ridge with rather angular edges, and extends for a short distance down the shell. This tube terminates anteriorly in the nearly rotund aperture.

"Length, 3.4 mm.; breadth, 0.9 mm." (Bagg.)

Formation and locality.—Navesink marl, Atlantic Highlands (Bagg).

Geographic distribution.—New Jersey.

Frondicularia gaultina Reuss.

1860. *Frondicularia gaultina* Reuss, Sitz. Akad. Wiss Wien, vol. xl, p. 194, pl v, fig. 5.

1898. *Frondicularia gaultina* Bagg, Bull. U. S. G. S., No. 88, p. 48.

Description.—"Test rather narrow, smooth, very elongate, compressed; consisting of numerous chambers, gradually increasing in size from below upward; septal lines approximately straight, paralleled, depressed; shell broadest nearer the ultimate segment, gradually diminishing below; primordial segment not preserved.

"Length unknown." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg).

Geographic distribution.—New Jersey.

Frondicularia inversa Reuss.

1844. *Frondicularia inversa* Reuss, Geogn. Skizze Böhm., vol. ii, pt. 1, p. 211.

1845. *Frondiculara inversa* Reuss, Verstein. böhm Kreide, pt. 1, p. 31, pl. viii, figs. 15-19; pl. xiii, fig. 42.

1898. *Frondicularia inversa* Bagg, Bull. U. S. G. S., No. 88, p. 48.

Description.—"Test complanate, leaf-like, elongate, smooth, broadest near the middle, tapering at the sides toward the anterior and posterior ends by straight wedge-shaped lateral margins; peripheral edges square; one lateral surface slightly curved along the median line, opposite surface approximately flat; chambers 10 to 12, narrow, elongate, nearly parallel to upper peripheral edges; primordial chamber oval, elevated, marked by a median ridge, mucronate; apertue rotund, crenulated.

"Length, 2.82 mm.; breadth, 1 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg).

Geographic distribution.—New Jersey.

Frondicularia lanceola Reuss.

1865. *Frondicularia lanceola,* Reuss's Model No. 23 (Catalogue No. 46, 1861).

1898. *Frondicularia lanceola* Bagg, Bull. U. S. G. S., No. 88, p. 49.

Description.—"Test very elongate, lanceolate, tapering sharply to an acute point at the primordial end; segments numerous, 12 or more, quadrangular in cross section; septa depressed sharply, so that the chambers appear elevated into oblique folds; surface smooth and glistening; peripheral margin limbate; ultimate chamber extended into a distinct tube, which carries the oral aperture; primordial chamber nearly circular, not elevated; aperture radiate.

"Length, 3 mm.; breadth, 0.6 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg).
Geographic distribution.—New Jersey.

Frondicularia major Bornemann.

Plate II., Fig. 27.

1854. *Frondicularia major* Bornemann, Liasform, Göttingen, p. 36, pl. iii, figs. 21 a-c.
1898. *Frondicularia major* Bagg, Bull. U. S. G. S., No. 88, p. 49, pl. iii, fig. 3.

Description.—"Test smooth, compressed, somewhat thicker along the median line, thinner at the peripheral margins, which are neatly rounded; chambers varying from four to nine; somewhat convex forward; septal lines distinct; posterior margin obtusely rounded; anterior acuminate; aperture a central radiate opening.

"Length, 1-4 mm.; breadth, 1.6 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Frondicularia ovata Roemer.

Plate II., Figs. 28–29.

1840. *Frondicularia ovata* Roemer, Verstein, norddeutsch. Kreid., p. 96, pl. xv, fig. 9.
1898. *Frondicularia ovata* Bagg, Bull. U. S. G. S., No. 88, p. 49, pl. iv, figs. 2 a, 2 b.

Description.—"Test ovate, complanate, smooth; consisting of a small number of parallel chambers, which are distinct and marked very slightly at the lower peripheral edges by the septal endings; primordial chamber flat, basal; ultimate chamber large, slightly prolonged into the rounded aperture; peripheral margins rather squarely set off.

"Length, 9.82 mm." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg); Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Frondicularia pulchella Karrer.

1870. *Frondicularia pulchella* Karrer, Jahrb, k. k. geol. Reichsanstalt, vol. xx, p. 171, pl. i, fig. 8.

1898. *Frondicularia pulchella* Bagg, Bull. U. S. G. S., No. 88, p. 49.

Description.—"Test large, elongated, complanate; surface smooth, marked by rather distinct septal lines, which separate the narrow, extended, parallel chambers; greatest width near the middle of the shell, thence tapering rather sharply toward both extremities, but the lower portion slightly incurved, while the anterior end is slightly outcurved, though not markedly so; primordial segment lost.

"Length, about 5 mm.; breadth (central), 1.8 mm." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg).

Geographic distribution.—New Jersey.

Frondicularia reticulata (Reuss).

Plate II., Fig. 30.

1850. *Flabellina reticulata* Reuss, Haidinger's Nat. Abhandl., vol. iv, pt. 1, p. 30, pl i, fig. 22.

1898. *Frondicularia reticulata* Bagg, Bull. U. S. G. S., No. 88, p. 50, pl. 3, fig. 6.

Description.—"Test thin, leaf-like, broad at the center, but tapering rapidly toward the oral end; consisting of 10 rather narrow, elongated chambers, the surfaces of which are marked transversely by numerous delicate costæ, which run from septum to septum, and completely cover the whole form like a network; primordial chamber nearly circular, but not elevated, very slightly eccentric, yet not enough to justify its being placed among flabelline types.

"Length, 0.87 mm.; greatest breadth, 0.88 mm." (Bagg.)

Remarks.—"This is one of the most beautiful of all frondicularians, and is at the same time exceedingly rare. We have only one specimen from the Lower Marl at Freehold, and it is interesting to note that Professor Reuss records the single occur-

rence of a perfect specimen from the Kreidemergel of Lemberg." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg).

Geographic distribution.—New Jersey.

Frondicularia verneuilina d'Orbigny.

1840. *Frondicularia verneuilina* d'Orbigny, Mém. Soc. géol. France, ser. 1, vol. iv, p. 20, pl. i, figs. 32, 33.

1898. *Frondicularia verneuilina* Bagg, Bull. U. S. G. S., No. 88, p. 50.

Description.—"Test elongate elliptical; peripheral margins gracefully curved, broadest near the center, not compressed laterally as much as most Frondicularia; chambers relatively large, few; primordial segment globose, costate, mucronate, distinctly set off from the succeeding chamber; ultimate chamber prolonged into a tubular neck, which carries the little round aperture.

"Length, 1.5 mm." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg).

Geographic distribution.—New Jersey.

Genus Rhabdogonium Reuss.

Rhabdogonium roemeri Reuss.

1860. *Rhabdogonium roemeri* Reuss, Sitz. Akad. Wiss. Wien., vol. xl, p. 201, pl. vi, fig. 7.

1898. *Rhabdogonium roemeri* Bagg, Bull. U. S. G. S., No. 88, p. 51.

Description.—"Test coarsely arenaceous, partly composed of glauconite grains, elongate, straight, or slightly bent, sharply triangular, obtusely rounded and slightly angular at the ends; peripheral margin curved, sharp; chambers few in number, usually six, short, separated by arched depressed septa; aperture elliptical, placed centrally at the distal end.

"Length, 1.5 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg).

Geographic distribution.—New Jersey.

Rhabdogonium tricarinatum (d'Orbigny).

Plate II., Figs. 31–32.

1826. *Vaginulina tricarinata* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 258, No. 4; Modèle, No. 4.
1861. *Rhabdogonium pyramidale* Karrer, Sitz. Akad. Wiss. Wien, vol. xvi, p. 19, pl. i, fig. 34.
1884. *Rhabdogonium tricarinatum* Brady, Chal. Rept., vol. ix, p. 525, pl. lxvii, figs. 1-3.
1898. *Rhabdogonium tricarinatum* Bagg, Bull. U. S. G. S., No. 88, p. 51.

Description.—"Test triangular, elongated and gradually tapering toward both extremities; peripheral margins sharp, becoming slightly twisted below; anterior end prolonged into a tube-like neck; chambers about 10, narrow, arched, and separated by curved septa; aperture rotund.

"Length, 2.6 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Brownsville (Bagg).

Geographic distribution.—New Jersey.

Rhabdogonium tricarinatum var. acutangulum Reuss.

1862. *Rhabdogonium tricarinatum* var. *acutangulum* Reuss, Sitz. Akad. Wiss. Wien, vol. xlvi, Abth. 1, p. 55, pl. iv, fig. 14, a, b.
1898. *Rhabdogonium tricarinatum* var. *acutangulum* Bagg, Bull. U. S. G. S., No. 88, p. 51.

Description.—"Test small, trihedral, coarsely arenaceous; the three marginal angles sharp and distinct; chambers few, short, separated by somewhat arched septa, not very distinct externally; primordial end sharp, anterior obtusely angular; aperture triangular, with incurved lateral edges.

"Length, 1.73 mm." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg).

Geographic distribution.—New Jersey.

Genus MARGINULINA d'Orbigny.

Marginulina ensis Reuss.

1845. *Marginulina ensis* Reuss, Verstein. böhm. Kreide, pt. 1, p. 29, pl. xii, fig. 13; pl. xiii, figs. 26, 27; pt. 2, p. 106, pl. xxiv, fig. 30.

1894. *Nodosaria communis* Woodward, Jour. N. Y. Microsc. Soc., vol. x, No. 4, p. 103.

1898. *Marginulina ensis* Bagg, Bull. U. S. G. S., No. 88, p. 51.

Description.—"Test elongate, moderately compressed, oval or elliptical in transverse section; shell variable in outline, either nearly straight throughout its whole length or incurved; septa very slightly oblique, directed toward the primordial chamber, apparent externally as ridges; proximal chambers more involute than in *Marginulina elongata;* chambers numerous, apparent externally; ultimate chamber somewhat prolonged, and ending posteriorly in a short tube; aperture rotund, with crenulated margin.

"Length, 1.3, 1.73 mm.; breadth, 0.43 mm." (Bagg.)

Remarks.—"Professor Sherborn prefers to change the word Marginulina to Cristellaria for this species, thus making it *Cristellaria ensis* (Reuss). The writer prefers to leave it under the original name of Professor Reuss." (Bagg.)

Formation and locality.—Navesink marl, Bruere's pits on Crosswicks Creek (Bagg); Hornerstown marl, Blue Ball (Bagg); Vincentown limesand, Mullica Hill, New Egypt (Bagg).

Geographic distribution.—New Jersey.

Marginulina pediformis Bornemann.

1855. *Marginulina pediformis* Bornemann, Zeitsch. d. Deutsch. geol. Gessell., vol. vii, p. 326, pl. xiii, fig. 13.

1898. *Marginulina pediformis* Bagg, Bull. U. S. G. S., No. 88, p. 52.

Description.—"Test smooth, short, circular in transverse section; consisting of about six chambers, of which the first two or

three are inrolled and rounded at the base; segments becoming more definite above; ultimate chamber largest and slightly prolonged; aperture small, rotund, crenulate; septa depressed, slightly oblique, though not markedly so.

"Length, 1 mm." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg).

Geographic distribution.—New Jersey.

Marginulina trilobata d'Orbigny.

1840. *Marginulina trilobata* d'Orbigny, Mém. Soc. géol. France, ser. 1, vol. iv, p. 16, pl. i, figs. 16, 17.

1898. *Marginulina trilobata* Bagg, Bull. U. S. G. S., No. 88, p. 52.

Description.—"Test elongate, smooth, and glistening, compressed laterally, slightly arcuate at the primordial end; somewhat tapering; chambers short, oval, regular, numerous, 10 to 16, slightly constricted; surfact marked by small, distinct, elliptical ridges, giving the form a peculiar trilobed appearance, whence its name; primordial chamber small, nearly spherical; septal lines depressed; aperture small, radiate.

"Length, 4 mm. in large specimens; breadth, 0.6 mm." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg); Navesink marl, Freehold (Bagg).

Geographic distribution.—New Jersey.

Genus VAGINULINA d'Orbigny.

Vaginulina legumen (Linné).

Plate II., Fig. 33.

1758. *Nautilus legumen* Linné, Syst. Nat., tenth ed., p. 711, No. 248; 1767, twelfth ed., p. 1164, No. 288.

1891. *Vaginulina legumen* Terrigi, Memoire R. Com. g. Regno, vol. iv, pt. 1, p. 94, pl. iii, fig. 6.

1895. *Vaginulina legumen* Bagg, Johns Hopkins Univ. circ., vol. 15, No. 121, p. 12.

1898. *Vaginulina legumen* Bagg, Bull. U. S. G. S., No. 88, p. 53, pl. 4, fig. 4.

1898. *Vaginulina legumen* Bagg, Bull. Am. Pal., vol. 2, No. 10, p. 26 (320).

1901. *Vaginulina legumen* Bagg, Md. Geol. Surv. Eocene, p. 240, pl. 63, fig. 1.

Description.—"Test straight or nearly so, smooth, compressed laterally, pod-like; consisting of only six or seven chambers; septa nonlimbate, oblique, parallel, not very distinct externally; ultimate chamber slightly prolonged upon one side and carrying the small radiate aperture.

"Length, 1.3 mm.; breadth, 0.47 mm." (Bagg.)

Remarks.—"The above species has been lately described from the Alabama chalk by Dr. Woodward. It is a beautiful little shell, of snow-white color, and is rather rare." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg); Vincentown limesand, New Egypt, Mullica Hill (Bagg).

Geographic distribution.—New Jersey, Alabama; Eocene of Maryland.

Vaginulina strigillata (Reuss).

Plate II., Fig. 34.

1845. *Citharina strigillata* Reuss, Verstein. böhm. Kreide, pt. 2, p. 106, pl. xxiv, fig. 29.

1860. *Vaginulina strigillata* and var. Jones and Parker, Quart. Jour. Geol. Soc., vol. xvi, p. 453, pl. xx, figs. 29-35.

1898. *Vaginulina strigillata* Bagg, Bull. U. S. G. S., No. 88, p. 53, pl. 4, fig. 3.

Description.—"Test, complanate, leaf-like, very large, roughly triangular; surface smooth, marked by slightly elevated septal lines; chambers numerous, often as many as 25, narrow, parallel, slightly oblique, becoming constricted toward the curved margin and passing rapidly downward toward the proximal end, where the septal lines finally appear only as fine ridges. As a

result of this constriction of the chambers at the curved margin, transverse sections show only four or five chambers. Along the straight edge run three elevated, rounded costæ, with sometimes one or two smaller ones between. The latter, however, do not extend the whole length of the shell as do the ridges. Septal lines distinct, slightly crenate, becoming much thickened toward the straight edge of the shell; primordial chamber oval, elevated, slightly mucronate, covered by numerous costæ.

"Length, 3-9 mm.; breadth, 2.3 mm." (Bagg.)

Remarks.—"This species is very common in the lower marl of Freehold, but I have not found it elsewhere." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg).

Geographic distribution.—New Jersey.

Cristellaria Lamarck.

Cristellaria acutauricularis (Fichtel and Moll).

Plate II., Figs. 35–36.

1803. *Nautilus acutauricularis* Fichtel and Moll, Test. Micros., p. 102, pl. xviii; figs. *g-i.*

1840. *Cristellaria navicula* d'Orbigny, Mém. Soc. géol. France, vol. iv, ser. 1, p. 27, pl. ii, figs. 19, 20.

1884. *Cristellaria acutauricularis* Brady, Chal. Rept., vol. ix, p. 543, pl. cxiv, fig. 17 *a, b.*

1898. *Cristellaria acutauricularis* Bagg, Bull. U. S. G. S., No. 88, p. 54.

Description.—"Test involute, thick, convex, smooth; septal plane broad, triangular, nearly flat; chambers seven or eight, weakly curved; keel acute carinate; aperture nipple-shaped, situated at the extremity of the convex side.

"Length, 1.43 mm.; breadth, 0.65 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Timber Creek (Bagg).

Geographic distribution.—New Jersey.

Cristellaria articulata (Reuss).

Plate II., Figs. 37–38.

1863. *Robulina articulata* Reuss, Sitzungsber. K. Akad. Wiss. Wien, vol. 48, p. 53, pl. v, fig. 62.
1870. *Cristellaria articulata* Reuss, Sitzungsber. K. Akad. Wiss. Wien, vol. 62, p. 483.
1884. *Cristellaria articulata* Brady, Challenger Report, vol. 9, p. 547, pl. lxix, figs. 10-12, also figs. 1-4.
1898. *Cristellaria articulata* Bagg, Bull. U. S. Geol. Survey No. 88, p. 54.
1905. *Cristellaria articulata* Bagg, Bull. U. S. G. S., No. 268, p. 34, pl. 6, fig. 1.

Description.—"Test nearly circular, smooth, thickened, flattened at the sides; obtusely angular peripheral margin; chambers six or seven, broadly triangular, separated by depressed septa; aperture oval, surrounded by a fissured border.

"Diameter, 1.3 mm." (Bagg.)

Remarks.—"Prof. Brady considers this species a thick variety of *Cristellaria rotulata.*" (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Mullica Hill, Timber Creek (Bagg).

Geographic distribution.—New Jersey; Miocene of California.

Cristellaria cassis (Fichtel and Moll).

Plate II., Figs. 39–40.

1798. *Nautilus cassis* Fichtel and Moll, Test. Microsc., p. 95, pl. xvii, figs. a, 1.
1816. *Cristellaria cassis* Lamarck, Tabl. Encyl. et Méthod., pl. cccclxvii, figs. 3 a-d.
1884. *Cristellaria cassis* Brady, Challenger Report, vol. 9, pp. 552, 553, pl. lxviii, fig. 10.
1898. *Cristellaria cassis* Bagg, Bull. U. S. Geol. Survey No. 88, p. 54.
1899. *Cristellaria cassis* Silvestri, Mem. Accad. Lincei, vol. 15, pp. 206-212, pl. vii, figs. 13-17.

1900. *Cristellaria cassis* Chapman, Proc. California Acad. Sci., ser 3, vol. 1, p. 250, pl. xxix, fig. 18.

1905. *Cristellaria cassis* Bagg, Bull. U. S. G. S., No. 268, p. 35, pl. 6, fig. 2.

Description.—"Test very large, complanate, elongate oval, distinctly carinate; chambers irregular, 10 to 15 in final volution; septa distinct, arcuate, depressed; aperture oval with crenulated margin.

"Length, 4.3-4.56 mm.; breadth, 3-4 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Brownsville, New Egypt, etc. (Bagg.)

Geographic distribution.—New Jersey; Miocene of California.

Cristellaria crepidula (Fichtel and Moll).

Plate II., Figs. 41–42.

1803. *Nautilus crepidula* Fichtel and Moll, Test. Microsc., p. 107, pl. xix, figs. g-i.

1839. *Cristellaria crepidula* d'Orbigny, Foram. Cuba, p. 64, pl. viii, figs. 17, 18.

1865. *Crestellaria crepidula* Parker and Jones, Philos Trans., vol. 155, p. 344, pl. xiii, figs. 15, 16, pl. xvi, fig. 4.

1884. *Cristellaria crepidula* Brady, Challenger Report, vol. 9, pp. 542, 543, pl. lxvii, figs. 17, 19, 20; pl. lxviii, figs. 1, 2.

1898. *Cristellaria crepidula* Bagg, Bull. U. S. Geol. Survey No. 88, p. 55.

1905. *Cristellaria crepidula* Bagg, Bull. U. S. G. S., No. 268, p. 35, pl. 6, fig. 3.

Description.—"Test elongate, arcuate, smooth, compressed, pellucid; chambers 10 to 12, oblique, separated by slightly convex walls; posterior chambers involute, anterior chambers evolute; aperture rotund, slightly crenate.

"Length, 0.7 mm.; breadth, 0.26 mm." (Bagg.)

Remarks.—"The above form is not a common species. Our specimens are similar in shape to *Cristellaria intermedia* Reuss,

which is considered as identical with the above by Professor Brady." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Mullica Hill (Bagg).

Geographic distribution.—New Jersey; Miocene of California.

Cristellaria cretacea Bagg.

Plate III., Figs. 1–2.

1898. *Cristellaria cretacea* Bagg, Bull. U. S. G. S., No. 88, p. 55, pl. 5, figs. 2 a-b.

Description.—"Test complanate, smooth, elongate, oval, resembling *Cristellaria cassis* in general contour, but differing from that species in the absence of the marginal keel; margin rounded; chambers numerous, about 12 in final convolution, narrow, elongated; septa distinct, convex; ultimate chamber truncate, anterior margin straight; aperture small, narrow elliptical, with crenulated margin.

"Length, 4.3 mm.; breadth, 3 mm." (Bagg.)

Remarks.—"The above species is less elongated than *Cristellaria projecta,* which it resembles closely.

"These two forms, together with *Cristellaria cassis,* are rather abundant at Vincentown, and all attain an enormous size for the type." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Cristellaria cultrata (Montfort).

Plate III., Fig. 3.

1808. *Robulus cultratus* Montfort, Conch. Syst., vol. i, p. 214, 54^{e} genre.

1846. *Robulina cultrata* d'Orbigny, Foram. Foss. Bassin tert. Vienne, p. 96, pl. iv, figs. 10-13.

1865. *Cristellaria cultrata* Parker and Jones, Phil. Trans., vol. 155, p. 344, pl. 13, figs. 17-18, pl. 16, fig. 5.

1898. *Cristellaria cultrata* Bagg, Bull. U. S. G. S., No. 88, p. 55, pl. 6, fig. 1.

1898. *Cristellaria cultrata* Bagg, Bull. Am. Pal., vol 2, No. 10, p. 26 (320).

1904. *Cristellaria cultrata* Bagg, Md. Geol. Surv., Miocene, p. 474, pl. 132, fig. 15.

Description.—"Test circular, biconvex, smooth and glistening, peripheral margin sharp, broadly keeled; chambers 7 to 11, in final convolution, somewhat convex, smooth or costate; aperture radiate.

"Diameter, 1-2 mm." (Bagg.)

Remarks.—"This species is common at Freehold and is beautifully preserved. The width of the marginal keel is variable, as is also the number of chambers. It is similar to *Cristellaria rotulata,* with the addition of the keel. Specimens of *Cristellaria cultrata* from New Egypt and Swedesboro are not smooth, as in typical forms, but are marked externally by raised septa." (Bagg.)

Formation and locality.—Navesink marl, Freehold, Bruere's pits on Crosswicks Creek, Marlboro (Bagg); Vincentown limesand, Mullica Hill, New Egypt, Swedesboro, Timber Creek (Bagg).

Geographic distribution.—New Jersey; Miocene of Maryland and Virginia.

Cristellaria gibba d'Orbigny.

Plate III., Figs. 4-5.

1839. *Cristellaria gibba* d'Orbigny, Foram. Cuba, p. 63, pl. vii, figs. 20, 21.

1855. *Cristellaria excisa* Bornemann, Zeitsch. d. Deutsch Geol. Gesell., vol. 7, p. 328, pl. 13, figs. 19-20.

1862. *Cristellaria pulchella* Reuss, Sitzungsb. d. k. Akad. Wiss. Wien, vol. 46, p. 71, pl. 8, fig. 1.

1863. *Cristellaria concinna* Reuss, Sitzungsb. d. k. Akad. Wiss. Wien, vol. 48, p. 52, pl. 5, fig. 58.

1884. *Cristellaria gibba* Brady, Challenger Report, vol. 9, pp. 546, 547, pl. lxix, figs. 8, 9.

1898. *Cristellaria gibba* Bagg, Bull. U. S. G. S.,No. 88, p. 56.

1900. *Cristellaria gibba* Chapman, Proc. California Acad. Sci., ser. 3, vol. 1, No. 8, pl. xxx, fig. 3.

1905. *Cristellaria gibba* Bagg, Bull. U. S. G. S., No. 268, p. 37, pl. 6, fig. 6.

Description.—"Test oblong, biconvex, smooth, subcarinate, narrow; chambers few (seven or eight), slightly arcuate, separated by distinct septa; aperture marginate.

"Length, 1.3 mm.; breadth, 0.87 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Mullica Hill, Timber Creek (Bagg).

Geographic distribution.—New Jersey; Miocene of California.

Cristellaria italica (Defrance).

Plate III., Figs. 6-7.

1824. *Sarecenaria italica* Defrance, Dict. Sci. Nat., vol. xxxii, p. 177; vol. xlvii, p. 344; Atlas Conch., pl. xiii, fig. 6.

1884. *Cristellaria italica,* Brady, Chal. Rept., vol. ix, p. 544, pl. lxviii, figs. 17, 18, 20-23.

1898. *Cristellaria italica* Bagg, Bull. U. S. G. S., No. 88, p. 56, pl. 4, figs. 5 a, b.

Description.—"Test elongate, trihedral, planospiral segments few, succeeding chambers five or six, arranged in a nearly straight superimposed series; dorsal margin sharp, noncarinate; transverse section triangular, segments short, slightly oblique, inclined anteriorly toward initial end.

"Length, 1 mm." (Bagg.)

Remarks.—"This is not a common species. It bears some resemblance to *Cristellaria acutauricularis,* but is more elongate, and the anterior edge is more erect. Another species, closely allied to the above form, is *Marginulina triangularis* d'Orbigny."[1] (Bagg.)

Formation and locality.—Hornerstown marl, Blue Ball (Bagg); Vincentown limesand, near Swedesboro, Mullica Hill (Bagg).

Geographic distribution.—New Jersey.

[1] Foram. Foss. Bassin tert. Vienne, 1846, p. 71, Pl. III, figs. 22, 23.

Cristellaria mamilligera Karrer.

Plate III., Fig. 8.

1864. *Cristellaria mamilligera* Karrer, Novara Exped. Geol., vol. i, pt. 2, p. 76, pl. xvi, fig. 5.

1884. *Cristellaria mamilligera* Brady, Chal. Rept., vol. ix, p. 553, pl. lxx, figs. 17, 18.

1898. *Cristellaria mamilligera* Bagg, Bull. U. S. G. S., No. 88, p. 56.

Description.—"Test complanate nearly circular; anterior margin truncate, posterior margin slightly carinate; surface ornamented with a number of large raised ridges and tubercles in the umbilical region; septa depressed, the depressions partially filled by exogenous material which forms the ridges; chambers large, slightly arcuate, eight or nine in the final convolution; septal plane narrow, surrounded by a definite border; aperture an elongate oval opening surrounded by a crenulated margin.

"Diameter, 1.74 mm." (Bagg.)

Remarks.—"This species is very rare in the green marl of Blue Ball, and has not been recognized elsewhere."

Formation and locality.—Hornerstown marl, Blue Ball (Bagg).

Geographic distribution.—New Jersey.

Cristellaria megapolitana (Reuss).

Plate III., Figs. 9–10.

1855. *Robulina megapolitana* Reuss, Zeits. d. Deutsch geol. Gesell., vol. vii, p. 272, pl. ix, fig. 5.

1898. *Cristellaria megapolitana* Bagg, Bull. U. S. G. S., No. 88, p. 57.

Description.—"Test circular compressed, smooth and glistening, keeled and with more or less definite flange. There are seven or eight strongly curved chambers apparent externally as raised lines, which are thicker at the umbilicus, but become attenuated toward the peripheral margin. Umbilical disk more or less distinct. Septal plane triangular, with raised border.

"Length, 1–1.5 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg).

Geographic distribution.—New Jersey.

Cristellaria projecta Bagg.

Plate III., Figs. 14–15.

1895. *Cristellaria projecta* Bagg, Johns Hopkins Univ. circulars, No. 121, p. 11.

1898. *Cristellaria projecta* Bagg, Bull. U. S. G. S., No. 88, p. 57, pl. 5, figs. 1 a, b.

Description.—"Test greatly elongated, complanate, smooth, consisting of two and one-half convolutions; chambers numerous, 20 or more in the last volution, arcuate, narrow, elongate, ultimate chamber nearly at right angles to umbilicus; margin rounded; septal lines very slightly depressed; aperture elliptical.

"Length, 5.3 mm.; breadth, 2.7 mm." (Bagg.)

Remarks.—"This is a rare form in the limesand at Vincentown, and has not been found elsewhere." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Cristellaria rotulata (Lamarck).

Plate III., Figs. 11–12.

1804. *Lenticulites rotulata* Lamarck, Ann. du Mus., vol. 5, p. 188, No. 3.

1840. *Cristellaria rotulata* d'Orbigny, Mém. Soc. géol. France, ser. 1, vol. iv., p. 26, pl. ii, figs. 15-18.

1865. *Cristellaria rotulata* Parker and Jones, Phil. Trans., vol. 155, p. 345, pl. 13, fig. 19.

1884. *Cristellaria rotulata* Brady, Challenger Report, vol. 9, p. 547, pl. lxix, fig. 13.

1892. *Cristellaria rotulata* Dervieux, Boll. Soc. Geol. Italiana, vol. 10, p. 626.

1898. *Cristellaria rotulata* Bagg, Bull. U. S. Geol. Survey No. 88, pp. 57, 58.

1898. *Cristellaria rotulata* Bagg, Bull. Am. Pal., vol. 2, No. 10, p. 27 (321).

1901. *Cristellaria rotulata* Bagg, Md. Geol. Surv., Eocene, p. 242, pl. 63, fig. 5.

1905. *Cristellaria rotulata* Bagg, Bull. U. S. G. S., No. 268, p. 37, pl. 5, fig. 7.

Description.—"Test involute, biconvex, smooth; peripheral edge sharp, noncarinate; chambers numerous, but only eight or nine in final volution; septa moderately curved, visible externally as fine lines; aperture elliptical, radiate.

"Diameter, 1-2 mm." (Bagg.)

Remarks.—"This is one of the most common forms in the limesand bed, and is especially plentiful at Vincentown. The size of the shell is very variable, some of the largest specimens being more than 2 millimeters in diameter." (Bagg.)

Formation and locality.—Hornerstown marl, Blue Ball (Bagg); Vincentown limesand, Vincentown, Mullica Hill, New Egypt, Timber Creek (Bagg); Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey; Eocene of Maryland, Miocene of California.

Cristellaria secans Reuss.

1859. *Cristellaria secans* Reuss, Sitz. Akad. Wiss. Wien, vol. xl, p. 214, pl. ix, fig. 7.

1898. *Cristellaria secans* Bagg, Bull. U. S. G. S., No. 88, p. 58.

Description.—"Test circular, laterally compressed, sharply keeled on the peripheral margin; umbilical disc prominent and septa radiating from this in gently curving lines; about 10 small triangular chambers in the last convolution.

"Diameter, 1.5 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg).

Geographic distribution.—New Jersey.

Cristellaria trachyomphala (Reuss).

1850. *Robulina trachyomphala* Reuss, Haidinger's Nat. Abhandl., vol. iv, pt. 1, p. 34, pl. iii (error for ii), fig. 12.

1898. *Cristellaria trachyomphala* Bagg, Bull. U. S. G. S., No. 88, p. 58.

Description.—"Test rounded, compressed, with angular periphery; umbilical disc raised, nearly round, more marked in some forms than others; septal lines distinct, convex. There are from 8 to 10 chambers in the last whorl. Aperture a triangular-shaped opening surrounded by a raised crenulated margin at the external edge of the ultimate segment.

"Diameter, 0.86-1.3 mm." (Bagg.)

Formation and locality.—Hornerstown marl, Blue Ball (Bagg).

Geographic distribution.—New Jersey.

Cristellaria triangularis d'Orbigny.

1840. *Cristellaria triangularis* d'Orbigny, Mém. Soc. géol. France, ser. 1, vol. iv, p. 27, pl. ii, figs. 21, 22.

1845. *Cristellaria triangularis* Reuss, Verstein. böhm. Kreide, pt. 1, p. 34, pl. viii, fig. 48.

1898. *Cristellaria triangularis* Bagg, Bull. U. S. G. S., No. 88, p. 58.

Description.—"Test triangular, very convex, smooth; periphery sharply carinate; lateral surfaces somewhat concave; chambers few, six or seven, large, evolute, superposed; septa oblique, very slightly convex anteriorly; septal plane broadly triangular; aperture radiate.

"Length, 1 mm." (Bagg.)

Remarks.—"The occurrence of this species from the craie blanche of the Paris basin, France, was recorded by d'Orbigny as early as 1840. I have found but two specimens in the lower marl of Freehold." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg).

Geographic distribution.—New Jersey.

Cristellaria wetherellii (Jones).

Plate III., Fig. 13.

1854. *Marginulina wetherellii* Jones, Morris Catalogue, Brit. Foss., ed. 2, p. 37.

1884. *Cristellaria wetherellii* Brady, Chal. Rept., vol. ix, p. 537, pl. cxiv, fig. 14.
1898. *Cristellaria wetherellii* Bagg, Bull. U. S. G. S., No. 88, p. 59.
1898. *Cristellaria wetherellii* Bagg, Bull. Am. Pal., vol 2, No. 10, p. 27 (321).
1904. *Cristellaria wetherellii* Bagg, Md. Geol. Surv., Miocene, p. 475, pl. 132, fig. 16.

Description.—"Test elongate, pod-like, compressed; primordial segments spiral, ultimate segments straight, evolute; surface marked by large tubercles more or less regular and crossing the shell surface like septal ridges; aperture round, at the end of a somewhat prolonged neck.

"Length, 1.56 mm.; breadth, 0.5 mm." (Bagg.)

Remarks.—"The above species is rare at Vincentown. Dr. Woodward states that it is rare at Mullica Hill, but common at Timber Creek." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Mullica Hill, Timber Creek (Bagg).

Geographic distribution.—New Jersey; Miocene of Maryland.

Genus Flabellina d'Orbigny.

Flabellina cordata Reuss.

1845. *Flabellina cordata* Reuss; Verstein. böhm. Kreide, pt. 1, p. 32, pl. viii, figs. 37-46, 78.
1854. *Flabellina cordata* Reuss, Denks. Akad. Wiss. Wien, vol. vii, p. 67, pl. xxv, figs. 6-8.
1898. *Flabellina cordata* Bagg, Bull. U. S. G. S., No. 88, p. 59.

Description.—"Test broadly ovate or heart-shaped, complanate, with numerous narrow, elongated chambers; primordial chamber somewhat elevated and more or less globular, succeeding chambers at first flabelline, later Frondicularia-like; anterior extremity wedge-like with gently curving sides, posterior border much wider than in *Flabellina sagittaria* and differing from that species in the irregularity of the basal margin caused by the

extension of the primordial chamber; surface of test smooth and glistening; aperture a small radiate, terminal opening.

"Length, 1.8-4 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Brownsville (Bagg).

Geographic distribution.—New Jersey.

Flabellina sagittaria (Lea).

Plate III., Figs. 16–17.

1833. *Palmula sagittaria* Lea, Contributions to Geol., pp. 219-220, pl. vi, fig. 228.

1842. *Planularia cuneata* Morton, Jour. Acad. Nat. Sci., Philadelphia, vol. viii, pt. 2, p. 214, pl. xi, fig. 5.

1898. *Flabellina sagittaria* Bagg, Bull. U. S. G. S., No. 88, p. 59, pl. 4, figs. 1 a-b.

Description.—"Test complanate, broadly elliptical (sometimes rather narrow and more elongate), occasionally slightly convex along the median line, while the opposite side is concave, though in typical specimens both surfaces are flat; septa distinct, forming a sharp median angle; chambers numerous, the number dependent somewhat upon the size of the individual; peripheral margins moderately rounded; primordial chamber bulbous, mucronate, or more usually smooth; surface smooth and glistening; aperture typically mammillate, though frequently the shell is worn or broken off so that a round opening appears.

"Length, 1-9 mm.; breadth, 1-4.3 mm." (Bagg.)

Remarks.—"This species is one of the most common forms at Vincentown. It is very variable in size and shape and is found in all stages or growth. As has been previously stated, it was the first Foraminifera to be described from the New Jersey greensands." (Bagg.)

Formation and locality.—Hornerstown marl, Blue Ball (Bagg); Vincentown limesand, Vincentown, New Egypt, Brownsville, etc. (Bagg).

Geographic distribution.—New Jersey.

Sub-family POLYMORPHININAE.

Genus POLYMORPHINA d'Orbigny.

Polymorphina compressa d'Orbigny.

Plate III., Fig. 20.

1846. *Polymorphina compressa* d'Orbigny, Foram. Foss. Bassin tert. Vienne, p. 233, pl. xii, figs. 32-34.

1870. *Polymorphina compressa* Brady, Parker and Jones, Trans. Linn. Soc. Lond., vol. 27, p. 227, pl. 40, figs. 12 a-f.

1898. *Polymorphina compressa* Bagg, Bull. U. S. G. S., No. 88, p. 60.

1898. *Polymorphina compressa* Bagg, Bull. Am. Pal., vol 2,, No. 10, p. 29 (323).

1901. *Polymorphina compressa* Bagg, Md. Geol. Surv., Eocene, p. 246, pl. 63, fig. 10.

1904. *Polymorphina compressa* Bagg, Md. Geol. Surv., Miocene, p. 476, pl. 133, fig. 1.

Description.—"Test oblong, compressed, inequilateral; chambers numerous, arranged biserially, somewhat inflated; septal lines depressed, surface smooth; aperture variable, usually simple, circular, and coronate, sometimes labyrinthic or porous.

"Length, 3 mm. in large specimens." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey; Eocene of Virginia, Miocene of Maryland and Virginia.

Polymorphina communis (d'Orbigny).

Plate III., Fig. 18.

1826. *Guttulina communis* d'Orbigny, Ann. Sci. Nat., Vol. vii, p. 266, pl. xii, figs. 1-4; Modèle, No. 62.

1870. *Polymorphina communis,* Brady, Parker, and Jones, Trans. Linn. Soc., London, vol. xxvii, p. 224, pl. xxxix, fig. 10 a-b.

1884. *Polymorphina communis* Brady, Chal. Rep., vol. 9, p.568, pl. 72, fig. 19.

1898. *Polymorphina communis* Bagg, Bull. U. S. G. S., No. 88, p. 60, pl. 6, fig. 2.

1898. *Polymorphina communis* Bagg, Bull. Am. Pal., vol. 2, No. 10, p. 29 (323).

1901. *Polymorphina communis* Bagg, Md. Geol. Surv., Eocene, p. 244, pl. 63, figs. 8-9.

Description.—"Test irregularly ovoidal, or egg-shaped, consisting of about four visible segments; anterior extremity acute; posterior obtuse; surface smooth, with distinct septal depressions; chambers inflated, elliptical, embracing; aperture mammillate.

"Length, 1.3-1.4 mm.; breadth, 1-1.3 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey; Eocene of Virginia.

Polymorphina emersoni Bagg.

Plate III., Fig. 19.

1898. *Polymorphina emersoni* Bagg, Bull. U. S. G. S., No. 88, p. 60, pl. 6, fig. 3.

Description.—"Test elongate oval, oral end acute, posterior obtusely rounded; surface of test covered completely by fine longitudinal costæ; chambers two, elongated, oblique, separated by nearly straight septa slightly marked near the posterior end and depressed at the peripheral margin; aperture rotund.

"Length, 1.9 mm." (Bagg.)

Remarks.—"This is a very rare species, and has only been obtained in the lower marl of Freehold." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg).

Geographic distribution.—New Jersey.

Polymorphina gibba (d'Orbigny).

Plate III., Fig. 21.

1826. *Globulina gibba* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 266, No. 20; Modèle No. 63.

1870. *Polymorphina gibba* Brady, Parker and Jones, Trans. Linn. Soc. London, vol. xxvii, p. 216, pl. xxxix, fig. 2 a-d.

1884. *Polymorphina gibba* Brady, Chal. Rep., vol. 9, p. 561, pl. 71, fig. 12.

1898. *Polymorphina gibba* Bagg, Bull. U. S. G. S., No. 88, p. 61.

1898. *Polymorphina gibba* Bagg, Bull. Am. Pal., vol. 2, No. 10, p. 30 (324).

1901. *Polymorphina gibba* Bagg, Md. Geol. Surv., Eocene, p. 248, pl. 63, fig. 12.

1904. *Polymorphina gibba* Bagg, Md. Geol. Surv., Miocene, p. 477, pl. 133, fig. 4.

Description.—"Test subglobular, apex slightly produced, base obtusely rounded; consisting of from two to four chambers, compactly joined and overlapping; surface smooth, unmarked by septal constrictions; septa visible as delicate, oblique lines, laterally very slightly compressed, though usually nearly circular in transverse section; shell larger than *Polymorphina lactea,* less elongated toward the apex; aperture mammillate.

"Diameter, 0.5-1.17 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg); Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey; Eocene of Maryland and Virginia, Miocene of Maryland.

Polymorphina lactea (Walker and Jacob).

Plate III., Figs. 22–23.

1798. *Serpula lactea* Walker and Jacob (fide Kanmacher); Adams's Essays, second ed., p. 634, pl. xxiv, fig. 4.

1858. *Polymorphina lactea* Williamson, Recent Foram. Gt. Brit., p. 71, pl. 6, fig. 147.

1870. *Polymorphina lactea* Brady, Parker and Jones, Trans. Linn. Soc. Lond., vol. 27, p. 213, pl. 39, figs. 1 a-c.
1884. *Polymorphina lactea* Brady, Chal. Rept., vol. ix, p. 559, pl. lxxi, fig. 11 (typical), pl. lxxii, fig. 14 (variety).
1898. *Polymorphina lactea* Bagg, Bull. U. S. G. S., No. 88, p. 61.
1898. *Polymorphina lactea* Bagg, Bull. Am. Pal., vol. 2, No. 10, p. 31 (325).
1901. *Polymorphina lactea* Bagg, Md. Geol. Surv., Eocene, p. 248, pl. 63, fig. 13.
1904. *Polymorphina lactea* Bagg, Md. Geol. Surv., Miocene, p. 477, pl. 133, figs. 5-6.

Description.—"Test ovate or subpyriform, only slightly compressed; three or four chambers, scarcely visible externally; aperture terminal, radiate.

"Diameter, 0.87 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg); Hornerstown marl, Blue Ball (Bagg); Vincentown limesand, Vincentown, New Egypt, Timber Creek (Bagg).

Geographic distribution.—New Jersey; Eocene of Maryland, Miocene of Maryland.

Polymorphina lactea elongate variety Brady.

Plate III., Figs. 24–25.

1884. *Polymorphina lactea* elongate variety Brady, Chal. Rept., vol. ix, p. 559, pl. lxxi, fig. 14.
1898. *Polymorphina lactea* elongate variety Bagg, Bull. U. S. G. S., No. 88, p. 61.

Description.—"Test similar to the preceding, but elongated.

"Length, 1.5 mm.; breadth, 0.6 mm." (Bagg).

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Polymorphina oblonga d'Orbigny.

1846. *Polymorphina oblonga* d'Orbigny, Foram. Foss. Bassin tert. Vienne, p. 232, pl. xii, figs. 29-31.
1898. *Polymorphina oblonga* Bagg, Bull. U. S. G. S., No. 88, p. 62.

Description.—"Test elongate, consisting of a small number of oblong inflated chambers separated by deep sutures. This feature separates it from *Polymorphina lactea* var. *oblonga* Williamson, which has an oval compressed shell with erect segments and flush sutures.

"Length, 1.43 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg); Vincentown limesand, Timber Creek (Bagg).

Geographic distribution.—New Jersey.

Polymorphina orbignii (Zborzewski).

Plate III., Fig. 26.

1834. *Apiopterina d'orbignii* Zborzewski, Nouv. Mém. Soc. Imp. Nat. Moscou, vol. iii, p. 311, pl. xxviii, fig. 2 b.
1870. *Polymorphina orbignii* Parker, Jones and Brady, Trans. Linn. Soc. London, vol. xxvii, p. 244, pl. xlii, fig. 38 a-c.
1898. *Polymorphina orbignii* Bagg, Bull. U. S. G. S., No. 88, p. 62.

Description.—"Test oval, with a fistulose base; surface of shell smooth. The tube-like projections are very interesting and peculiar, and are the distinguishing feature of the species. They surround the base like a crown, extend out irregularly, and branch at their distal ends. The figures of this species indicate septal divisions, but these are not discernible externally.

"Diameter, 0.87 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Polymorphina problema (d'Orbigny).

Plate III., Figs. 27–28.

1826. *Guttulina problema* d'Orbigny, Ann. Sci. Nat., vol. vii, p. 266, No. 14, Modèle No. 61.

1870. *Polymorphina problema* Brady, Parker and Jones, Trans. Linn. Soc. London, vol. xxvii, p. 225, pl. xxxix, fig. 11, a-b.

1898. *Polymorphina problema* Bagg, Bull. U. S. G. S., No. 88, p. 62.

Description.—"Test oblong ovate, composed of several inflated chambers (six in one specimen) marked by strong septal depressions. Very similar to the more abundant *Polymorphina communis,* but differing from that species in the greater number of chambers. Surface of shell smooth; aperture small, rotund, radiate.

"Length, 1 mm.; breadth, 0.73 mm." (Bagg.)

Formation and locality.—Vincentown limesand, New Egypt, Mullica Hill, Timber Creek (Bagg).

Geographic distribution.—New Jersey.

Polymorphina regularis von Münster.

Plate III., Figs. 29–31.

1838. *Polymorphina regularis* von Münster (fide Rœmer), Neues Jahrb. für Min., p. 385, pl. iii, fig. 21.

1870. *Polymorphina regularis* Brady, Parker, and Jones, Trans. Linn. Soc. London, vol. xxvii, p. 229, pl. xl, fig. 13 a-c.

1898. *Polymorphina regularis* Bagg, Bull. U. S. G. S., No. 88, p. 63.

Description.—"Test oblong, compressed, biconvex, narrow below but somewhat broader above; peripheral margin thin, rounded; chambers four to nine, oblique; septal lines marked by slight constrictions visible externally; surface smooth; aperture small, round, central, surrounded by fine grooves.

"Length, 1–4 mm.; greatest breadth, 1.6 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Brownsville (Bagg).

Geographic distribution.—New Jersey.

Family GLOBIGERINIDAE.

Genus GLOBIGERINA d'Orbigny.

Globigerina bulloides d'Orbigny.

Plate III., Figs. 32–34.

1826. *Globigerina bulloides* d'Orbigny, Annales Sciences Naturelles, vol. 7, p. 277, No. 1, Modèle No. 17 (young) and No. 76.
1839. *Globigerina hirsuta* d'Orbigny, Foram. Canaries, p. 132, pl. ii, figs. 4–6.
1846. *Globigerina bulloides* d'Orb., Foram. Fors. Bassin tert. Vienne, p. 163, pl. 9, figs. 4–6.
1884. *Globigerina bulloides* Brady, Challenger Report, vol. 9, pp. 593, 594, 595, pls. lxxvii, lxxix, figs. 3–7.
1898. *Globigerina bulloides* Bagg, Bull. U. S. Geol. Survey, No. 88, p. 63.
1898. *Globigerina bulloides* Bagg, Bull. American Paleont., vol. 2, No. 10, p. 33 (327).
1901. *Globigerina bulloides* Bagg, Md. Geol. Surv., Eocene, p. 250, pl. 63, figs. 15, 16, 16 a.
1904. *Globigerina bulloides* Bagg, Md. Geol. Surv., Miocene, p. 468, pl. 132, figs. 1–2.
1905. *Globigerina bulloides* Bagg, Bull. U. S. G. S., No. 268, p. 41, pl. 7, fig. 7.

Description.—"Test spiral, subtrochoid; superior surface convex, inferior more or less convex, but with deeply sunken umbilicus, periphery rounded, lobulated; adult specimens composed of about seven globose segments, of which four form the outer convolution, the apertures of the individual chambers opening independently into the umbilical vestibule. Diameter, sometimes one-fortieth of an inch (0.63 mm.), but oftener much less." (Brady.)

Remarks.—"This species is not uncommon in the limesand at Vincentown, but it is rather rare in the overlying Manasquan marl beds. It is, however, much larger in the latter, and some specimens measure 0.4 mm. in diameter." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Swedesboro (Bagg); Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey; Eocene of Maryland and Virginia, Miocene of Maryland and Virginia.

Globigerina bulloides var. triloba Reuss.

Plate III., Fig. 35.

1849. *Globigerina triloba* Reuss, Denks. Akad. Wiss. Wien, vol. i, p. 374, pl. xlvii, fig. 11, a-e.
1884. *Globigerina bulloides* var. *triloba* Brady, Chal. Rept., vol. ix, p. 595, pl. lxxix, figs. 1, 2; pl. lxxxi, figs. 2, 3.
1898. *Globigerina bulloides* var. *triloba* Bagg, Bull. U. S. G. S., No. 88, p. 63.

Description.—"Test similar to *Globigerina bulloides,* but distinguished from the latter by its consisting of only three visible chambers in the final convolution. The diameter of the shell varies from 0.5 to 1 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg); Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Globigerina cretacea d'Orbigny.

1840. *Globigerina cretacea* d'Orbigny, Mém. Soc. Géol. France, ser. 1, vol. iv, p. 34, pl. iii, figs. 12–14.
1879. *Globigerina cretacea* Brady, Quart. Jour. Microsc. Soc. n. ser., vol. 19, p. 285.
1884. *Globigerina cretacea* Brady, Chal. Rept., vol. 9, pp. 596, 597, pl. 82, figs. 10 a-c (Fossil form, fig. 11).
1898. *Globigerina cretacea* Bagg, Bull. U. S. G. S., No. 88, p. 64.
1904. *Globigerina cretacea* Bagg. Md. Geol. Surv., Miocene, p. 469, pl. 132, fig. 3.

1905. *Globigerina cretacea* Bagg, Bull. U. S. G. S., No. 268, p. 42, pl. 8, fig. 1.

Description.—"Test rotaliform, but strongly depressed; superior surface flattened or but slightly convex, inferior side depressed toward the center and excavated at the umbilicus; periphery obtuse and lobulated; shell typically composed of three fairly distinct convolutions, the outermost consisting of from five to seven segments, the latter relatively small, subglobular; aperture opening into the umbilical vestibule.

"Diameter, less than 1 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg); Vincentown limesand, Quinton, Vincentown, Mullica Hill, Timber Creek, etc. (Bagg).

Geographic distribution.—New Jersey; Miocene of Maryland and California.

Family ROTALIDAE.

Sub-family ROTALINAE.

Genus DISCORBINA Parker and Jones.

Discorbina bertheloti (d'Orbigny).

Plate IV., Figs. 1–3.

1839. *Rosalina bertheloti* d'Orbigny, Foram. Canar., vol. ii, pt. 2, p. 135, pl. 1, figs. 28–30.

1884. *Discorbina bertheloti,* Brady, Chal. Rept., vol. ix, p. 650, pl. lxxxix, figs. 10–12.

1898. *Discorbina bertheloti* Bagg, Bull. U. S. G. S., No. 88, p. 64.

1898. *Discorbina bertheloti,* Bagg, Bull. Am. Pal., vol. 2, No. 10, p. 34 (328).

1901. *Discorbina bertheloti* Bagg, Md. Geol. Surv., Eocene, p. 251, pl. 64, fig. 1.

Description.—"Test very strongly compressed, carinate, perforate; spiral side approximately flat, reverse side low, convex; chambers depressed, numerous, convex, with limbate margins.

"Length, 1.22 mm.; breadth, 0.82 mm." (Bagg.)

Remarks.—"Similar to *Truncatulina lobatula,* but more depressed, and with more finely perforate walls." (Bagg.)

Formation and locality.—Hornerstown marl, Blue Ball (Bagg); Vincentown limesand, Timber Creek (Bagg).

Geographic distribution.—New Jersey; Eocene of Virginia.

Genus TRUNCATULINA d'Orbigny.

Truncatulina akneriana (d'Orbigny).

Plate IV., Figs. 4–6.

1846. *Rotalina akneriana* d'Orbigny, Foram. Foss. Bassin tert. Vienne, p. 156, pl. viii, figs. 13–15.

1866. *Truncatulina akneriana* Reuss, Denks. Akad. Wiss. Wien, vol. xxv, p. 160, No. 6.

1884. *Truncatulina akneriana* Brady, Chal. Rept., vol. ix, p. 663, pl. xciv, fig. 8, a, b, c.

1898. *Truncatulina akneriana* Bagg, Bull. U. S. G. S., No. 88, p. 64.

Description.—"The superior face of the test of *Truncatulina akneriana* is flat, the inferior convex at the margin, but depressed toward the umbilicus; and the convolutions are not completely involute on the inferior side, as in *Truncatulina lobatula,* but leave a portion of the earlier whorls visible at the center." (Brady.)

"Diameter, 0.43 mm." (Bagg.)

Remarks.—"This form is commonly associated with *Truncatulina lobatula* or *Truncatulina ungeriana,* or with both, and has a similar distribution." (Bagg.)

Formation and locality.—Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Truncatulina haidingerii (d'Orbigny).

Plate IV., Figs. 7–9.

1846. *Rotalina haidingerii* d'Orbigny, Foram. Foss. Bassin tert. Vienne, p. 154, pl. vii, figs. 7, 9.

1851. *Rotalina ehrenbergii* Bailey, Smithsonian Cont. to Knowl., vol. 11, art. 3, p. 10, figs. 11–13.

1884. *Truncatulina haidingerii* Brady, Chal. Rept., vol. ix, p. 663, pl. xcv, fig. 7, a-c.

1898. *Truncatulina haidingerii* Bagg, Bull. U. S. G. S., No. 88, p. 65.

1898. *Truncatulina haidingerii* Bagg, Bull. Am. Pal., vol. 2, No. 10, p. 35 (329).

Description.—"Test circular, biconvex, trochoid; volutions three, chambers marked by slightly depressed septa on inferior side, about twelve segments in the last convolution; aperture a small marginal slit.

"Diameter, 0.58 mm." (Bagg.)

Remarks.—"The above species is similar to *Truncatulina ungeriana,* but differs from it in being more valuted and less depressed at the umbilicus. It is also a smaller form and is not so abundant, being rather rare in the middle marl bed. There is, furthermore, no distinct groove following the whorls upon the superior side, and the perforations are smaller than in *Truncatulina ungeriana.*" (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown (Bagg).

Geographic distribution.—New Jersey; Eocene of Virginia.

Truncatulina lobatula (Walker and Jacob).

Plate IV., Figs. 10–12.

1798. *Nautilus lobatulus* Walker and Jacob, Adam's Essays, Kanmacher's ed., p. 642, pl. xiv, fig. 36.

1884. *Truncatulina lobatula* Brady, Challenger Report, vol. 9, pp. 660, 661, pl. xcii, fig. 10; pl. xciii, figs. 1, 4, 5; pl. cxv, figs. 4, 5.

1895. *Truncatulina lobatula* Egger, Jahrsber. Naturalist, Ver. Passau, vol. 16, p. 31, pl. v, fig. 5, a, b, c.

1898. *Truncatulina lobatula* Bagg, Bull. U. S. Geol. Survey, No. 88, p. 65.

1898. *Truncatulina lobatula* Bagg, Bull. Am. Pal., vol. 2, No. 10, p. 35 (329).

1901. *Truncatulina lobatula* Bagg, Md. Geol. Surv., Eocene, p. 252, pl. 64, fig. 3.
1904. *Truncatulina lobatula* Bagg, Md. Geol. Surv., Miocene, p. 464, pl. 131, figs. 7–8.
1905. *Truncatulina lobatula* Bagg, Bull. U. S. G. S., No. 268, p. 46, pl. 9, fig. 1.

Description.—"Test plano-convex, moderately vaulted; last volution consisting of seven or eight chambers, with very slightly depressed septa; septa more curved upon the superior (flat) surface; aperture a small, neatly shaped arch at the margin of the ultimate segment.

"Diameter, 0.36–1.13 mm." (Bagg.)

Remarks.—"The above species shows great variation. Professor Brady considers that the more convex varieties merge into *Truncatulina refulgens,* while flattened forms resemble *Truncatulina wuellerstorfi.* The regular-built convex varieties constitute the *Truncatulina boueana* of d'Orbigny, and the less regular the *Truncatulina variabilis* of the same author." (Bagg.)

Formation and locality.—Marshalltown clay-marl, Marshalltown (Bagg); Navesink marl, Freehold (Bagg); Vincentown limesand, New Egypt, Mullica Hill (Bagg); Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey; Eocene of Maryland and Virginia, Miocene of Maryland and California.

Truncatulina refulgens (Montfort).

Plate IV., Figs. 13–15.

1808. *Cibicides refulgens,* Montfort, Conch. Syst., vol. i, p, 122, 31[e] genre.
1884. *Truncatulina refulgens,* Brady, Chal. Rept., vol. ix, p. 659, pl. xcii, figs. 7–9.
1898. *Truncatulina refulgens* Bagg, Bull. U. S. G. S., No. 88, p. 66.

Description.—"Test subconical, superior surface complanate, inferior very much elevated; consisting of about eight chambers in the last convolution; sutures somewhat depressed upon the in-

ferior (vaulted) surface; peripheral margin sharp; aperture an inframarginal opening near the base of the ultimate segment.

"Diameter, 0.5 mm." (Bagg.)

Remarks.—"There is a possibility that this is an Eocene fossil, as it was obtained from some of the uppermost greensand of the New Jersey Cretaceous, which carries a number of Eocene fossils, together with some of late Cretaceous age. The specimens came from the upper marl bed at Vincentown, and only a very few forms were found." (Bagg.)

Formation and locality.—Manasquan marl ?, Vincentown (Bagg).

Geographic distribution.—New Jersey.

Truncatulina ungeriana (d'Orbigny).

Plate IV., Figs. 16–18.

1846. *Rotalina ungeriana,* d'Orbigny, Foram. Foss. Bassin tert. Vienne, p. 157, pl. viii, figs. 16–18.
1884. *Truncatulina ungeriana,* Brady, Chal. Rept., vol. ix, p. 664, pl. xciv, fig. 9, a-d.
1898. *Truncatulina ungeriana* Bagg, Bull. U. S. G. S., No. 88, p. 66.
1901. *Truncatulina ungeriana* Bagg, Md. Geol. Surv., Eocene, p. 253, pl. 64, fig. 4.

Description.—"Test large, rotaliform, circular, coarsely porous, both sides moderately convex, unequal, depressed slightly on the inferior side at the umbilicus, consisting of three convolutions. The last volution consists of from 10 to 12 limbate chambers. Septa arched; aperture a median semilunar slit.

"Diameter, 0.78 mm." (Bagg.)

Remarks.—"This species is rather common at New Egypt. In the upper marl bed the forms are much smaller, the shell being only about one-half the size of the New Egypt specimens." (Bagg.)

Formation and locality.—Vincentown limesand, New Egypt (Bagg); Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey; Eocene of Maryland.

Truncatulina wuellerstorfi (Schwager).

Plate IV., Figs. 19–21.

1866. *Anomalina wuellerstorfi* Schwager, Novara-Exped., Geol., vol. 2, p. 258, pl. vii, figs. 105, 107.

1884. *Truncatulina wuellerstorfi* Brady, Challenger Report, vol. 9, p. 662, pl. xciii, figs. 8, 9.

1886. *Truncatulina wuellerstorfi* Uhlig, Jahrb. K.-k. geol. Reichsanstalt, vol. 36, p. 174, fig. 3.

1895. *Truncatulina wuellerstorfii* Egger, Jahrsber, Naturhist. Ver. Passau, vol. 16, p. 31, pl. v, fig. 6 a, b, c.

1898. *Truncatulina wuellerstorfi* Bagg, Bull. U. S. G. S., No. 88, p. 66.

1905. *Truncatulina wuellerstorfi* Bagg, Bull. U. S. G. S., No. 268, p. 47, pl. 9, fig. 3.

Description.—"Test circular, coarsely porous; inferior surface convex, superior complanate; peripheral edge acute; chambers narrow; septa strongly curved, crescent-shaped with broad septal ridges, nine in the last convolution; aperture a small marginal cleft.

"Diameter, 0.5 mm." (Bagg.)

Remarks.—"This species is similar in its outline to figure 8, plate xciii, Challenger Report, vol ix. None of our specimens are as flat as figure 9 of the same plate, which Professor Brady considers the more typical form. This author states that this species is described from the Pliocene deposits of Kar Nicobar by Schwager, but does not mention its earlier occurrence. It is an intermediate form between *Truncatulina lobatula* and *Anomalina ariminensis.*" (Bagg.)

Formation and locality.—Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey; Miocene of California.

Genus ANOMALINA d'Orbigny.

Anomalina ammonoides (Reuss).

Plate IV., Figs. 26–29.

1845. *Rosalina ammonoides* Reuss, Verstein. böhm. Kreid., pt. 1, p. 36, pl. xiii, fig. 66; pl. viii, fig. 53.

1870. *Rotalia ammonoides* Gümbel, Sitzungsber. K. bayer. Akad. Wiss., p. 283.
1872. *Planorbulina ammonoides* Jones and Parker, Quart. Jour. Geol. Soc. London, vol. 28, p. 106; table, p. 109.
1884. *Anomalina ammonoides* Brady, Challenger Report, vol. 9, pp. 672, 673, pl. xciv, fig. 2, 3.
1898. *Anomalina ammonoides* Bagg, Bull. U. S. G. S., No. 88, p. 67, pl. vi, fig. 5.
1901. *Anomalina ammonoides* Bagg, Md. Geol. Surv., Eocene, p. 254, pl. 64, fig. 5.
1905. *Anomalina ammonoides* Bagg, Bull. U. S. G. S., No. 268, p. 47, pl. 9, fig. 4.

Description.—"Test nautiloid, coarsely porous, small, compressed; lateral surfaces nearly equally convex; depressed at the umbilici; peripheral edge round; aperture an arched, nearly medium slit upon the inner margin of the ultimate segment.

"Diameter, 0.5–0.8 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold, Bruere's pits on Crosswicks Creek (Bagg); Vincentown limesand, Vincentown, New Egypt, Timber Creek (Bagg).

Geographic distribution.—New Jersey; Eocene of Maryland, Miocene of California.

Anomalina grosserugosa (Gümbel).

Plate IV., Figs. 22–25.

1868. *Truncatulina grosserugosa,* Gümbel, 1868; Abhandl. d. k. bayer. Akad. Wiss., vol. x, p. 660, pl. ii, fig. 104, a. b.
1875. *Truncatulina grosserugosa* Hautken, Mittheil. K. ung. geol. Anstalt, vol. 4, p. 74, pl. 9, figs. 6 a-b.
1884. *Anomalina grosserugosa* Brady, Challenger Report, vol. 9, p. 673, pl. xciv, figs. 4, 5.
1898. *Anomalina grosserugosa* Bagg, Bull. U. S. G. S., No. 88, p. 67, pl. vi, fig. 4.
1899. *Anomalina grosserugosa* Sherborn and Chapman, Jour. Roy. Microsc. Soc., p. 487, pl. xi, fig. 34.

1900. *Anomalina grosserugosa* Chapman, Proc. California Acad. Sci., ser. 3, vol. 1, No. 1, pp. 253, 254, pl. xxx, fig. 9.

1901. *Anomalina grosserugosa* Bagg, Md. Geol. Surv., Eocene, p. 254, pl. 64, fig. 6.

1905. *Anomalina grosserugosa* Bagg, Bull. U. S. G. S., No. 268, p. 48, pl. 9, fig. 6.

Description.—"Test nautiloid, very coarsely porous, pores larger and more numerous upon inferior surface; both sides convex; umbilici distinct; peripheral margin round; chambers large, inflated, only eight in final convolution; septa nearly straight; aperture median, arched.

"Diameter, 0.43-0.82 mm." (Bagg.)

Remarks.—"The above species is very similar to *Anomalina ammonoides*, but differs from it in being relatively larger and thicker, with a smaller number of chambers in the final convolution, and also in its more obtusely rounded margin." (Bagg.)

Formation and locality.—Vincentown limesand, Swedesboro (Bagg); Manasquan marl, Vincentown (Bagg).

Geographic distribution.—New Jersey; Eocene of Maryland, Miocene of California.

Genus PULVINULINA Parker and Jones.

Pulvinulina karsteni (Reuss).

Plate IV., Figs. 30–32.

1855. *Rotalia karsteni* Reuss, Zeit. d. Deutsch. geol. Gesell., vol. vii, p. 273, pl. ix, fig. 6.

1861. *Rotalia karsteni* Reuss, Sitz. Akad. Wiss. Wien., vol. xliv, pt. 1, p. 337.

1884. *Pulvinulina karsteni* Brady, Chal. Rept., vol. ix, p. 698, pl. cv, figs. 8, 9.

1898. *Pulvinulina karsteni* Bagg, Bull. U. S. G. S., No. 88, p. 67.

Description.—"Test circular, regularly built, convex on both sides, with obtuse-angular periphery; composed of from three

to four convolutions; septal markings on superior surface apparent as fine lines, while the lower surface shows slight depressions of the radiating septa; last convolution consisting of six or seven chambers; aperture a cleft on the lower side somewhat removed from the margin.

"Length, 0.45-0.5 mm." (Bagg.)

Formation and locality.—Vincentown limesand, Vincentown, Quinton (Bagg).

Geographic distribution.—New Jersey.

Pulvinulina micheliniana (d'Orbigny).

1839. *Rotalina truncatulinoides* d'Orbigny, Foram. Canaries, vol. ii, pt. 2, p. 132, pl. ii, figs. 25-27.
1840. *Rotalina micheliniana* d'Orbigny, Mém. Soc. géol. France, ser. 1, vol. iv, p. 31, pl. iii, figs. 1-3.
1884. *Pulvinulina micheliniana* Brady, Chal. Rep., vol. ix, p. 694, pl. cvi, figs. 1-2.
1898. *Pulvinulina micheliniana* Bagg, Bull. U. S. G. S., No. 88, p. 68.

Description.—"Test orbicular, superior surface nearly flat, inferior highly convex, with an excavated umbilicus; spire complanate, with three convolutions; last volution consisting of 10 or 12 chambers, angular, separated by straight septal lines below; aperture elongate, slightly removed from the margin.

"Diameter, 0.45 mm." (Bagg.)

Remarks.—"This is not a common species, but was described by Prof. A. E. Reuss under the name *Rotalina nitida,* which he considered to be a young form of *Rotalina umbilicata* d'Orbigny. Dr. W. B. Carpenter considers that the *Rotalina umbilicata* of the Chalk is identical with *Rotalina soldanii* of the Vienna Tertiaries. Prof. H. B. Brady states that *Pulvinulina micheliniana* has its isomorph in *Truncatulina refulgens,* from which species it is distinguished by the more or less excavated umbilicus and the projecting apical margins of the segments. In the Challenger Report, however, *Rotalina nitida* is not given under the synonyms of *Pulvinulina micheliniana,* but Dr. Woodward has so

considered it in his report on the Cretaceous Foraminifera of New Jersey, and it seems probable that this view is correct." (Bagg.)

Formation and locality.—Hornerstown marl, Blue Ball (Bagg); Vincentown limesand, Timber Creek (Bagg).

Geographic distribution.—New Jersey.

Pulvinulina reticulata Reuss var. **carinata** Bagg.

Plate IV., Figs. 33–34.

1898. *Pulvinulina reticulata* Reuss, var. *carinata* Bagg, Bull. U. S. G. S., No. 88, p. 68, pl. 5, figs. 3 a-b.

Description.—"Test discoidal, both sides moderately convex, peripheral margin possessing a large double keel; surface of shell smooth and shining, marked upon the superior surface by broad, curving septal lines; convolutions about three; eight chambers in the last volution; inferior surface less distinct, umbilicus marked by radiating lines nearly straight, but not distinct beyond one-third their length; no aperture visible.

"Diameter, 0.87 mm." (Bagg.)

Formation and locality.—Navesink marl, Freehold (Bagg).

Geographic distribution.—New Jersey.

CHAPTER II.

Branch COELENTERATA.

Class ANTHOZOA.

Order ZOANTHARIA.

Sub-order ZOANTHARIA SCLERODERMATA.

Family TURBINOLIDAE.

Genus FLABELLUM Lesson.

Flabellum mortoni Vaughan.

Plate V., Figs. 1–4.

1900. *Flabellum mortoni* Vaughan, Monog. U. S. G. S., vol. 39, p. 66, pl. 4, figs. 7-10.

Description.—Corallum cuneiform, base small, edges and faces converging towards it; cross-section elliptical. Outer surface of the corallum, when uninjured, covered by a smooth, polished epitheca; costæ absent or very slightly developed, when present they are low, usually flattish, and correspond to the interseptal areas. The septa are thin in the upper part of the corallum, in the lower portion they have undergone some secondary thickening, but apparently not to so great an extent as in some other species of the genus. The number of septa in an adult calice about 70, the actual number cannot be made out because of the condition of preservation of the specimens; the free margins of the septa show transverse undulations and the septal faces are granulate. (Adapted from Vaughan.)

The dimensions of a nearly complete corallum are: greatest diameter of the calice, 20.5 mm.; lesser diameter of the calice, 12 mm.; height of corallum, 21 mm.

Remarks.—This species is one of the three common forms of corals in the Manasquan marl, and may be easily distinguished from its associates by reason of its somewhat flattened corallum and its straight form. As it occurs in the marl beds the outer

wall has frequently been destroyed so that the edges of the septa are clearly seen upon the sides of the corallum.

Formation and locality.—Hornerstown marl, near New Egypt (142); Manasquan marl, near Farmingdale (138).

Geographic distribution.—New Jersey.

Genus TROCHOCYATHUS Milne-Edwards and Haime.

Trochocyathus woolmani Vaughan.

Plate V., Figs. 5–7.

1900. *Trochocyathus woolmani* Vaughan, Proc. Acad. Nat. Sci. Phil. (1900), p. 436.

1905. *Trochocyathus woolmani* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 4.

Description. Corallum short, attached, inversely conical, transverse outline circular. Wall rather thick, naked, ornamental externally by 24 costæ, corresponding to all cycles of septa, and showing a fairly regular alternation of larger and smaller—*i. e.*, there are 12 larger costæ of the same size corresponding to the septa of the first and second sycles, and 12 smaller corresponding to the septa of the third cycle; near the calice they are prominent, with acute edges and broad bases, as the base of the corallum is approached they decrease in prominence; they possess granulations along their edges, and some scattered granulations on the sides. Septa arranged in three cycles, divided into six systems; the septa of the first cycle are appreciably larger than the others, and pass directly from the corallum wall to the columellar space without forming any part of any septal group; the septa of the third cycle bend towards the members of the second, and fuse to the sides of the latter below the level of the calice; the septal margins project very slightly above the upper edge of the corallum wall; the septal faces are ornamented with distant subconical granulations. The inner end of each of the primary septa is thickened, the thickening apparently representing a palus, and before each group of the members of the second and third cycles is what appears to be a slender palus, therefore, there apparently are slender pali

before the septa of the first and second cycles. The columella is fasciculate, not large, with a papillary upper termination. The calicular fossa shallow.

The dimensions of the type specimen are: diameter of the calice, 3.5 mm.; height of corallum, 4 mm.; diameter of the area of attachment 1 mm. (Adapted from Vaughan.)

Formation and locality.—Woodbury clay ?, Artesian well, Mt. Laurel (Vaughan).

Geographic distribution.—New Jersey.

Trochocyathus conoides (Gabb and Horn).

Plate V., Figs. 8–10.

1860. *Trochosmilia conoides* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 399, pl. 69, figs. 12-13.

1900. *Trochocyathus conoides* Vaughan, Monog. U. S. G. S., vol. 39, p. 103, pl. 8, figs. 8-10.

1905. *Trochocyathus conoides* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 4.

Description.—Corallum short cornute, rapidly increasing in diameter, curved in the plane of the shorter transverse axis of the calice, cross-section elliptical. The wall of the corallum is solid and is apparantly covered by a thin, firm, pellicular epitheca, that seems to be applied to the wall in the same way as is the epitheca of *Flabellum,* although this can not be certainly determined because of the condition of preservation of the specimens. The outer surface of the corallum wall usually shows several longitudinal undulations, these being more numerous on the concave than upon the convex side, and also low, rounded costæ. When perfectly preserved, fine, longitudinal, raised striæ or longitudinal rows of small low granules may be detected upon the outer surface of the corallum. Septa about 64, the cycles and systems not very distinct; the first and second cycles and some members of the third reach the columellar space; the members of the third cycle usually fuse by their inner margins to the sides of those of the second, thus inclosing the members of the fourth cycle; when members of the fifth cycle are present, those

of the fourth will fuse to the sides of those of the third, thus inclosing the members of the fifth. The septal grouping does not seem to be absolutely regular, but the tendency to form septal groups is well pronounced. The septa are thin, somewhat flexuous near the center, thicker at the wall, all of them except the youngest member of each system, have distinct elongate elliptical or clavate thickenings on their inner ends, which are probably pali, and are arranged in two rather definite crowns. Septal faces granulated, no endotheca. Columella small, composed of a few more or less twisted ascending laths, to which the larger septa fuse by their flexuous inner margins. (Adapted from Vaughan.)

The dimensions of a nearly complete corallum are: greater diameter of the calice, 18 mm.; lesser diameter of the calice, 15 mm.; height of the corallum, 27 mm.

Remarks.—This species is the least common of the three which occur in the Manasquan marl, and may be easily distinguished from the others by the curvature of the corallum in the plane of the lesser axis of the calice, and, when the outer surface is well preserved, by the rows of fine granules.

Formation and locality.—Manasquan marl, near Farmingdale (138).

Geographic distribution.—New Jersey.

Genus PARACYATHUS Milne-Edwards and Haime.

Paracyathus vaughani n. sp.

Plate V., Figs. 11–13.

Description.—Corallum subcylindrical in form, with a broad spreading base so that the diameter of the basal disk by which it is attached is as great or greater than the thickest portion of the corallum above; immediately above the base the outer wall contracts somewhat abruptly for a short distance, and then increases gradually in diameter to the summit. The calice is very deep, reaching almost to the base of the corallum. The outer surface of the theca is marked by about 40 longitudinal, finely denticulate costæ, which continue across the expanded basal portion. The characters of the septa are not clearly shown in the type specimen, but they are apparently of the same number as the external costæ.

The dimensions of the type specimen are: diameter of corallum at base, 10 mm.; minimum diameter of corallum, 5.5 mm.; diameter of corallum at summit, 8 mm.; height of corallum, 14.5 mm.

Remarks.—A single example of this coral has been observed. It is a mould from which all the calcareous material of the corallum has been removed by solution. During life it grew attached to the inner surface of a dead pelecypod shell. The species may be distinguished from other members of the genus by its extremely broad basal attachment and by its remarkably deep calice.

Formation and locality.—Navesink marl, Mullica Hill (169).

Geographic distribution.—New Jersey.

Family FUNGIDAE.

Genus MICRABACIA Milne-Edwards and Haime.

Micrabacia americana Meek and Hayden.

Plate V., Figs. 14–17.

1860. *Micrabacia coronula* M. & H., Proc. Acad. Nat. Sci. Phil. (1860), p. 430 (Not *M. coronula* M.-Ed. & Haime, 1850).

1864. *Micrabacia Americana* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 2.

1876. *Micrabacia Americana* Meek, Inv. Cret. and Ter. Foss. Up. Mo., p. 1, pl. 28, figs. 1 a-d.

Description.—"Corallum small, subplano-convex, or slightly concave below, and convex with a rather deep central depression above. Intercostal foramina of the mural disk, oval and numerous. Rays or costæ of the under side straight, about 12 at the middle, but bifurcating so as to number near 100 around the periphery, apparently denticulate. Septa few at the center, but increasing by the intercalation of smaller ones between, so as to equal the number of the costæ, with which they alternate at the periphery, very finely and sharply denticulate on the upper and lateral edges."—*Meek.*

The dimensions of an average example are: width, 7.5 mm.; height, 2 mm.

Remarks.—This little coral has previously been recorded by Meek only from the Fox Hills fauna of the Upper Missouri section. In New Jersey the species has only been seen in the condition of moulds, the actual substance of the coral having been removed by solution. The impressions of the basal disk usually show very clearly the character of the radiating costæ, and it is from such specimens as this that the species is usually recognized, the impressions of the upper surface being much less perfectly preserved. The species is most abundant in the Woodbury clay, it being a rather common species at Lorillard; from the other horizons it has been rarely met with, usually a single example only having been observed.

Formation and locality.—Merchantville clay-marl, near Matawan (101[2]); Woodbury clay, Lorillard (102), near Matawan (103), near Haddonfield (183); Wenonah sand, near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey, South Dakota.

Family EUPSAMMIDAE.

Genus BALANOPHYLLIA Searles Wood.

Balanophyllia inauris Vaughan.

Plate V., Figs. 18–22.

1900. *Balanophyllia inauris* Vaughan, Monog. U. S. G. S., vol. 39, p. 171, pl. 19, figs. 12–14.

1905. *Balanophyllia inauris* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 4.

Description.—Corallum cornute, usually curved in the plane of the longer transverse axis of the calice, sometimes straight, and rarely slightly curved in the plane of the shorter axis of the calice; the area of attachment small. The costæ fine, low, granulate, usually not acute; subequal in size, or every fourth one slightly larger than the intervening three; the corallum wall perforate; girdling bands or shreds of epitheca are sometimes apparently present. Septa in five complete cycles; the members of the fifth

cycle standing next those of the first and second cycles are longer than the other members of the fifth cycle; the upper margins of the first and second considerably elevated, those of the third less so. Calice rather deep. Columella lax, spongy, not greatly developed. (Adapted from Vaughan.)

The dimensions of two nearly complete coralla are: greatest diameter of calice, 22.5 mm. and 16 mm.; lesser diameter of calice, 15.5 mm. and 13 mm.; height of corallum, 40+ mm. and 33 mm.

Remarks.—This species is the commonest one of the corals in the fauna of the Manasquan marl, and may sometimes be collected in great numbers upon the marl heaps near Farmingdale. It may be easily distinguished from *Trochocyathus conoides* by its finer costæ and by its curvature in the plane of the longer axis of the calice.

Formation and locality.—Manasquan marl, near Farmingdale (138), near New Egypt (155).

Geographic distribution.—New Jersey.

CHAPTER III.

Branch ECHINODERMATA.

Class CRINOIDEA.

Order ARTICULATA.

Family BOURGUETICRINIDAE.

Genus RHIZOCRINUS Sars.

Rhizocrinus cylindricus n. sp.[1]

Plate VI., Fig. 1.

Description.—Calyx cylindrical, slender and greatly elongate, the sides almost straight, not enlarging from the basals up. The proximal column joint (or joints?) higher than the basals and radials together, cylindrical above with straight sides, slightly contracted below. Basals much higher than the radials. Radial facets shallow, curved, rather wide, separate, low and not sloping upward, having no conspicuous muscle plate or ligament fossa. They enclose a relatively large and well excavated central funnel or visceral cavity.

The dimensions of the type specimen are: height of proximal column joint and calyx together, 9.3 mm.; diameter, 3 mm.; height of proximal column joint, 6 mm.

Remarks.—This species is established on a single complete calyx and proximal stem joint, although numerous isolated column joints may belong to the same species. The specimen is clearly a member of the family Bourgeticrinidae, and superficially resembles, in some respects, *Bourgueticrinus ellipticus* and *B. aequalis* from the white chalk of England, but it differs from these species in the much greater height of the basals. The character of the radial facets and the large visceral cavity, however,

[1] The writer is indebted to Mr. Frank Springer for valuable suggestions regarding the relationship of this species.

seem to remove it from that genus. In the great height of the basals the species agrees with members of the genus *Rhizocrinus*, but that genus is described as having a thin, disk-like proximal stem joint, while the New Jersey species apparently has an exceedingly high one in which no transverse divisions can be detected. There seems to be no reason, however, why some latitude may not be allowed in this character. The genus *Rhizocrinus* has not heretofore been recognized earlier than the Eocene, but there is no reason why it should not also occur in the higher Cretaceous beds.

The species is possibly allied to *Bourgueticrinus alabamensis* De Loriol, a species which Carpenter thinks should be referred to the genus *Rhizocrinus*.[1] The New Jersey species differs from that species in its much more elongate and more slender form.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Family PENTACRINIDAE.

Genus PENTACRINUS Miller.

Pentacrinus bryani Gabb.

Plate VI., Figs. 8–9.

1876. *Pentacrinus bryani* Gabb, Proc. Acad. Nat. Sci. Phil., 1876, p. 178, pl. 5, figs. 1, 1 a-b.

1893. *Pentacrinus bryani* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 51.

1893. *Pentacrinus bryani* Clark, Bull. U. S. G. S., No. 97, p. 28, pl. 3, figs. 3 a-b.

1905. *Pentacrinus bryani* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—Column distinctly pentagonal, composed of moderately large, thick segments, whose breadth in the type specimen is 6 mm., and thickness nearly 1 mm. Salient angles of the column rounded and forming a nearly unbroken line; the

[1] Challenger Reports, Vol. XI., p. 257.

furrows at the reentrant angles alternately depressed and elevated in successsive segments. The upper and lower outer margins of the segments slightly rounded. The crenulations of the articular faces of the segments visible externally, they are arranged in five broad petaloid areas distinctly rounded externally, the crenulations themselves being confined to a marginal band, from the inner edge of the reentering angles of the column, the crenulated band is continued as a flat-topped double ridge that reaches to and is confluent with a slight elevation surrounding the axial canal. Axial canal small.

Remarks.—This species is known only from a few small fragments of the column. Of the two original specimens, one consists of seven segments, the other of eight or nine. No trace of the body of the crinoid has been observed. So far as known it is the only representative of the *Pentacrinidae* in the Cretaceous faunas of America.

Formation and locality.—Vincentown limesand, Vincentown (Gabb).

Geographic distribution.—New Jersey.

Class ASTEROIDEA.

Order PHANEROZONIA.

Genus GONIASTER Agassiz.

Goniaster mammilata Gabb.

Plate VI., Figs. 10–17.

1876. *Goniaster mammilata* Gabb, Proc. Acad. Nat. Sci. Phil., 1876, p. 178, pl. 5, figs. 2, 2 a-b.

1893. *Goniaster mammillata* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 51.

1893. *Goniaster mammillata* Clark, Bull. U. S. G. S., No. 97, p. 32, pl. 5, figs. 1 a-h.

1905. *Goniaster mammillata* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—Known only from detached marginal plates. These plates differ widely in form because of their different posi-

tions upon the margin of the star-fish, but most of them are higher than wide and are swollen on the outer surfaces. Surface of the plates finely punctate, the depressions being arranged in rows that intersect at right angles.

Remarks.—The remains of star-fishes are among the rarest fossils in the Cretaceous rocks of America. The form and size of the individual of which the plates here described were a part cannot be determined, and it is not worth while to attempt to make comparisons with other forms. The only other American star-fishes known from the Cretaceous is *Pentagonaster browni* Weller,[1] from near the summit of the Cretaceous beds near Lander, Wyoming, and *Pentaceros asperulus,* described below. All of these forms are members of the order Phanerozonia, characterized by the presence of highly developed marginal plates, but the detached plates from New Jersey are quite different from those of the Wyoming specimen.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Genus PENTACEROS Quick.

Pentaceros asperulus n. sp. Clark.

Plate VI., Figs. 18–19.

Description.—Known only from detached body plates, which are irregular in outline, the intermittent articulating surfaces on the perimeter producing a roughly polygonal outline. The surface of the plates uneven, the irregularly flattened areas providing attachment for spines. The central portion of the plates is higher than the truncated margins.

The dimensions of one plate are: length, 6.5 mm.; width, 4 to 5 mm.; thickness, 3.5 mm.

Remarks.—The body of the star-fishes of this genus, whose form is known, is pentagonal, with long, narrow arms: the surface is covered with irregularly shaped plates that touch intermittently at their margins, their surfaces being uneven and bearing spines. Two or three well-preserved specimens of the small sur-

[1] Jour. Geol., vol. 13, pp. 257–258.

face plates of a *Pentaceros* have been found by Clark. They are so highly characteristic that their generic relations are clearly apparent. As no other Cretaceous representatives of this genus have been found in American deposits they are given a specific name as they cannot be readily associated with any known European species.

Formation and locality.—Vincentown limesand, Vincentown (Clark).

Geographic distribution.—New Jersey.

Class ECHINOIDEA.

Sub-Class EUECHINOIDEA.

Order CIDAROIDA.

Family CIDARIDAE.

Genus CIDARIS Klein.

Cidaris splendens (Morton).

Plate VII., Figs. 1–9.

1829. *Cidaris* (?) sp. Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 123.

1830. *Echinus* sp. Mort., Am. Jour. Sci., 1st ser., vol. 17, p. 287; vol. 18, pl. 3, figs. 12-13.

1834. *Echinus* Mort., Synop. Org. Rem. Cret. Gr. U. S., pl. 3, figs. 16-17.

1841. *Cidarites splendeus* Mort., Proc. Acad. Nat. Sci. Phil., vol. 1, p. 132.

1842. *Cidarites armiger* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 8, p. 215, pl. 2, fig. 1.

1859. *Cidaris armiger* Gabb, Cat. Inv. Foss. Cret. Form. U. S., p. 18.

1859. *Cidaris splendens* Gabb, Cat. Inv. Foss. Cret. Form. U. S., p. 18.

1891. *Cidaris armiger* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 75.

1893. *Cidaris splendens* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 51.

1893. *Cidaris splendens* Clark, Bull. U. S. G. S., No. 97, p. 33, pl. 6, figs. 3 a-g.

1905. *Cidaris splendens* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—Test of moderate size, spheroidal, the oral side slightly more depressed than the aboral. Ambulacral areas narrow, flexuous, with four rows of granules between the pore pairs, in the center of each column of plates these granules are approximately of equal size, the outer rows slightly larger, but towards the oral and aboral extremities the inner rows rapidly diminish in size and finally disappear; the pores are oval in shape, with funnel-like openings exteriorly, imperfectly defined granules forming an undulating ridge are present between the pores of each plate. Interambulacral areas very wide, with seven or eight plates in each column, each plate bearing a tubercle of large size characterized by a wide areola, smooth boss and small perforated mamelon, upon the larger plates in the center of each column the areolas are circular, but they become somewhat oval towards the oral and aboral extremities; the outer margin of each areola is surrounded by a circle of large granules that give it a crenulated appearance; the margin itself is depressed, and rises gradually at first, and then rapidly, to the boss which reaches a marked elevation above the general level of the plate. The miliary area is small and is covered with small, crowded granules that are more numerously developed along the median line of the interambulacra. The sutures are sharply defined and depressed. The spines are slender, elongated, cylindrical, with longitudinal, serrated ribs that gradually become obsolete towards the base, the collar is short and finely striated longitudinally; the acetabulum is bordered by a smooth margin and is perforated in the center.

The dimensions of a complete individual are: height, 21.9 mm.; width, 34.4 mm.

Remarks.—This species usually occurs in the form of detached plates, occasionally all or a part of one or more of the meridional areas are found still joined together, and Morton has illustrated a nearly complete example. The apical system of plates has in no case been observed. The species is similar to *C. serrata* Desor.,

from the European Cretaceous, but the American form differs from the European in its smaller miliary areas and higher areolas, also in the presence of only four rows of granules between the poriferous avenues. It may be distinguished from the associated *C. walcotti* by the perforated mamelons.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek (Morton).

Geographic distribution.—New Jersey.

Cidaris walcotti Clark.

Plate VII., Figs. 10–13.

1891. *Cidaris walcotti* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 75.

1893. *Cidaris walcotti* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103. p. 51.

1893. *Cidaris walcotti* Clark, Bull. U. S. G. S., No. 97, p. 37, pl. 6, figs. 4 a-d.

1905. *Cidaris walcotti* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—Test small, inflated. Ambulacral areas narrow, slightly sinuous, with four nearly equal rows of granules between the poriferous avenues, and at times with additional granules irregularly interspersed; the poriferous avenues themselves are narrow, deeply depressed, and slightly sinuous; the pores are round with funnel-shaped openings produced by the intersecting ridges; these ridges, which separate the individual pores and the pore pairs, give a lattice-like appearance to the poriferous zones. Interambulacral areas broad, plates moderately large, with the sutures indistinctly marked, and the small tubercles and numerous granules giving them a very evenly marked surface; the tubercles are circular and stand nearer the outer margins of the plates than the inner; the areolas are deeply depressed, their central portion but slightly exceeding the margin in height; the boss smooth, standing but little above the level of the plate; the mamelon small, imperforate; the wide miliary space covered with a large number of irregularly arranged granules of nearly uniform size.

The dimensions of a complete individual, as indicated by the size of a nearly complete interambulacral area, are: height, about 25 mm.; width ,about 37 mm.

Remarks.—This species occurs with *C. splendens,* but is much less common. It ordinarily occurs as detached plates, and these may be easily distinguished from those of *C. splendens* by reason of the broader miliary areas and the imperforate mamelon.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek (Clark).

Geographic distribution.—New Jersey.

Order DIADEMATOIDA.

Family SALENIIDAE.

Genus SALENIA Gray.

Salenia tumidula Clark.

Plate VIII., Figs. 1–10.

1891. *Salenia tumidula* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 75.

1893. *Salenia tumidula* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 51.

1893. *Salenia tumidula* Clark, Bull. U. S. G. S., No. 97, p. 41, figs. 1a-j.

1905. *Salenia tumidula* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—Test small, subglobose, the ventral surface flat, becoming depressed towards the oral opening, the sides inflated and regularly curved, passing into the convex dorsal surface. Ambulacral areas nearly straight, narrow, slightly increasing in width from the apical disk to the oral opening, with two rows, 15 or 16 each, of mamillated granules between the poriferous zones and between these, other minute granules; poriferous zones narrow and very slightly flexed; the pores circular, regularly arranged in unigeminal series, those in the middle of the test the largest. Interambulacral areas with five or six plates in each row, with indistinctly marked sutures; the larger

tubercles diminish rapidly in size toward the oral margin, becoming very indistinct on the plates bordering the same; each areola is large and circular, the boss crenulated and the mamelon flattened and imperforate; the miliary space is bordered with oval granules of irregular size and arrangement, becoming most numerous between the rows of tubercles. The apical disk large, prominent, subcircular, with a regularly curved convex surface; the granular decorations of the surface often coalesce and appear as broken ridges extending radially from the five openings in the genital plates; the anal opening is oval, slightly pointed below, it is bordered by a flange-like edge formed by the anal and two genital plates which project slightly above the surface of the disk. The oral opening is small, occupying scarcely two-fifths of the diameter of the test; ten incisions divide the margin into lobes, the ambulacral lobes projecting the farther.

The dimensions of a complete individual are: height, 9.4 mm; width, 12.5 mm.

Remarks.—This species most closely resembles *S. bellula* with which it is associated, but it has a more globular test, and the granules of the interambulacral plates are oval instead of circular. From *S. texana* it may be distinguished by the smaller number of mamillated granules of the interambulacral areas and by the far less strongly projecting anal opening.

Formation and locality.—Vincentown limesand, Timber Creek (Clark).

Geographic distribution.—New Jersey.

Salenia bellula Clark.

Plate VIII., Figs. 11–17.

1891. *Salenia bellula* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 75.

1893. *Salenia bellula* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103. p. 51.

1893. *Salenia bellula* Clark, Bull. U. S. G. S., No. 97, p. 43, pl. 11, figs. 2 a-g.

1905. *Salenia bellula* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—Test small, compressed, the ventral surface flat or slightly concave at the oral opening, the sides inflated, the upper surface regularly convex. Ambulacral areas rather broad, prominent and nearly straight, changing but slightly in width from the apical disk to the margin of the oral opening; two rows of mamillated granules, 15 in each row, occupy the center of each area between the poriferous zones and between these other minute granules are present; poriferous zones broad, very slightly flexed; pores circular, unigeminal. Interambulacral areas wide, with five or six plates in each row; the tubercles prominent, decreasing rapidly in size toward the margin of the oral opening; the areola of moderate size, the boss narrow and indistinctly crenulated, the mamelon small, flattened and imperforate; an interrupted row of circular, mamillated granules surrounds each tubercle, and between the rows of tubercles these granules unite to form a sinuous, double series; between the larger granules numerous smaller ones are scattered irregularly, being crowded together along the central line of the interambulacral area. Apical disk nearly circular, slightly convex, the plates decorated with oval granules arranged in radial rows extending from the opening of each genital plate and uniting with the corresponding rows of adjacent plates at the suture; the anal opening subcircular, with a flange-like rim, interfering but little with the regularity of the curved surface. The oral opening small, being but one-third the transverse diameter of the test, its margin divided by 10 slight incisions into lobes of nearly uniform size.

The dimensions of a complete test are: height, 6 mm.; width, 10 mm.

Remarks.—This species is closely allied to the last, but is more depressed, has a differently decorated apical disk, and has circular granules in the miliary space instead of oval.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek (Clark).

Geographic distribution.—New Jersey.

Family DIADEMATIDAE.

Genus PSEUDODIADEMA Desor.

Pseudodiadema diatretum (Morton).

Plate IX., Figs. 1–6.

1833. *Cidaris diatretum* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 294.
1834. *Cidarites diatretum* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 75, pl. 10, fig. 10.
1858. *Pseudodiadema diatretum* Desor, Synop. des Echin. Foss., p. 73.
1859. *Cidaris diatretum* Gabb, Cat. Inv. Foss. Cret. Form. U. S., p. 18.
1864. *Pseudodiadema diatretum* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 2.
1868. *Pseudodiadema diatretum* Con., Cook's Geol. N. J., p. 722.
1870. *Cidaris clavigera* and *Cidaris sceptrifera* Credner, Zeitsch. d. Deutsch. Geol. Gesell., vol. 22, p. 218.
1891. *Pseudodiadema diatretum* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 75.
1893. *Pseudodiadema diatretum* Clark, John Hopkins Univ. Circ., vol. 12, No. 103, p. 51.
1893. *Pseudodiadema diatretum* Clark, Bull. U. S. G. S., No. 97, p. 46, pl. 13, figs. 1 a-f.
1905. *Pseudodiadema diatretum* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—Test circular, depressed, concave below, the sides inflated, the dorsal surface slightly convex. Ambulacral areas wide, slightly raised, with two rows of 13 or 14 tubercles each, which are large and prominent at the ambitus, and decrease gradually towards the poles; the areolas broad, sharply depressed in their marginal portion, and marked by fine radial ridges on the outer sides; at the upper and inner angle of each plate is a small secondary tubercle, while scattered over the other portions of the plates are smaller tubercles, and between them minute granules;

the poriferous zones are narrow, slightly sinuous, three or four pairs of pores in each plate disposed in a curved series about the margin. Interambulacral areas about one and one-half times the width of the ambulacral, with two rows of primary tubercles somewhat larger than, but similar to those of the ambulacral areas; in addition there are several irregular rows of secondary tubercles, of various sizes, that are most numerous between the rows of primary tubercles and the poriferous zones, and also scattered, flattened granules. The primary tubercles of both the ambulacral and interambulacral areas have wide, circular areolas, elevated and deeply crenulated bosses, and distinctly perforated mamelons. The oral opening is narrow, scarcely more than one-third the diameter of the test, with slight marginal incisions. The discal opening pentagonal.

The dimensions of a complete test are: height, 12.5 mm.; width, 31.25 mm.

Formation and locality.—Vincentown limesand, Vincentown (154); Timber Creek (Clark).

Geographic distribution.—New Jersey.

Pseudodiadema speciosum (Clark).

Plate IX., Figs. 7–14.

1891. *Cyphosoma speciosum* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 76.

1893. *Coptosoma speciosum* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 51.

1893. *Coptosoma speciosum* Clark, Bull. U. S. G. S., No. 97, p. 52, pl. 18, figs. 1 a-h.

1905. *Coptosoma speciosum* Johns., Proc. Acad. Nat. Sci. Phil. 1905, p. 6.

Description.—Test circular, inflated at the sides, both poles flattened, the oral more than the aboral. Ambulacral areas wide and prominent, with two rows of primary tubercles of 12 or 13 each, which gradually diminish in size towards the poles; the areolas are nearly confluent above and below, and are marked by irregular radiating ridges; the bosses are deeply crenulate and

the small mamelons imperforate; minute tubercles and granules irregularly surround the primary tubercles, occuring in greatest number along the median suture; poriferous zones slightly sinuous, three or four pairs of pores in each plate arranged in a curved series along the margin; pores unigeminal. Interambulacral areas about one and one-half times as wide as the ambulacral, with two rows of primary tubercles somewhat larger than those of the ambulacra; the areolas very large, confluent above and below; throughout the greater part of the column the two rows approach each other, but towards the apical disk they become widely separated; the smaller tubercles are disposed in more or less regular rows on either side of the primary series. Oral opening small, occupying a little more than one-third of the diameter of the test, irregularly pentagonal in outline. Discal opening large, pentagonal in outline.

The dimensions of a complete test are: width, 17.2 mm.; height, 9.4 mm.

Remarks.—This species is very similar to *Pseudodiadema diatretum* in general form, and without close observation the two would not be separated. *P. speciosum,* however, is characterized by its imperforate mamelons and by the larger areolas of the interambulacral plates which are more completely confluent above and below. Clark has placed the two species in different genera, referring *P. speciosum* to the genus *Coptosoma,* but the differences between them seem to be no more than specific in importance. The characters used to distinguish the genera *Pseudodiadema* and *Coptosoma* are found in the arrangement of the elements which constitute the compound ambulacral plates, *Coptosoma* having a larger number of demi-plates. In the two species under discussion the number and arrangement of the pores themselves in each ambulacral plate is essentially identical, and the supposition would be that they are cogeneric, although the actual sutures between the elements of these compound plates have not been observed by the writer, nor have they been described or figured by Clark. *Coptosoma* ordinarily has a larger number of pairs of pores in each ambulacral plate, consequently these two species are both referred to *Pseudodiadema.*

Formation and locality.—Vincentown limesand, Timber Creek (Clark).

Geographic distribution.—New Jersey.

Family ECHINIDAE.

Genus PSAMMECHINUS Agassiz.

Psammechinus cingulatus Clark.

Plate X., Figs. 1–9.

1891. *Psammechinus cingulatus* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 76.

1893. *Psammechinus cingulatus* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 51.

1893. *Psammechinus cingulatus* Clark, Bull. U. S. G. S., No. 97, p. 55, pl. 20, figs. 1 a-i.

1905. *Psammechinus cingulatus* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—Test small, subhemispherical, with circular circumference, ventral side flattened, becoming somewhat concave towards the oral opening, sides inflated, dorsal surface elevated and moderately convex. Ambulacral areas wide, with 18 or 20 plates in each row; the lower 16 or 17 plates in each row bear prominent tubercles that occur in a continuous line to the peristome; on each side of these primary tubercles is a smaller one of similar shape, the inner one being situated towards the upper angle of the plate and the outer one towards the lower angle, besides these, several smaller tubercles or granules are present upon each plate; poriferous zones depressed, trigeminal, the three pore pairs of each plate arranged in semi-circular form, the two upper pairs separated from the lower by the outer secondary tubercle. Inter-ambulacral areas about one and one-half times as wide as the ambulacral with about 15 plates in each row; each plate with a large tubercle in the center, around which several smaller ones of various sizes are irregularly arranged. The tubercles of both ambulacral and interambulacral plates are similar in form, with a large, elevated, non-crenulated boss and an

imperforate mamelon. Oral opening large, with 10 deep incisions. The apical disk not observed, but the broken opening in the type specimen is large and pentagonal in outline.

The dimensions of the type specimen are: height, 12.5 mm.; width, 21.9 mm.

Remarks.—This species is the only American representative of the genus so far as known, and is quite distinct from any of the European forms.

Formation and locality.—Vincentown limesand, Timber Creek (Clark).

Geographic distribution.—New Jersey.

Order SPATANGOIDA.

Family ECHINOBRISSINAE.

Genus TREMATOPYGUS d'Orb.

Trematopygus cruciferus (Morton).

Plate XI., Figs. 1–9.

1830. *Ananchytes cruciferus* Mort., Am. Jour. Sci., 1st ser., vol. 18, p. 245, pl. 3, fig. 8.

1830. *Ananchytes cruciferus* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 201.

1833. *Nucleolites crucifer* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 294.

1834. *Nucleolites crucifer* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 75, pl. 3, fig. 15.

1855. *Trematopygus crucifer* d'Orb., Pal. Franc., Terr. Cret., vol. 6, p. 387, pl. 953, figs. 10–11, pl. 963, figs. 1–5.

1859. *Nucleolites crucifer* Gabb, Cat. Inv. Foss. Cret. Form. U. S., p. 19.

1864. *Nucleolites crucifer* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 2.

1868. *Nucleolites crucifer* Con., Cook's Geol. N. J., p. 377, figure; p. 722.

1870. *Nucleolites crucifer* Credner, Zeitsch. d. Deutsch. Geol. Gesell., vol. 22, p. 217.

1891. *Trematopygus crucifer* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 76.

1893. *Trematopygus crucifer* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 52.

1893. *Trematopygus crucifer* Clark, Bull. U. S. G. S., No. 97, p. 63, pl. 27, figs 1 a-i.

1905. *Trematopygus crucifer* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 7.

Description.—Test ovate, very slightly contracted anteriorly, the sides and the outer portion of the base inflated. Ambulacral areas long, lanceolate, well-defined, unequal, the posterior pair the longest and the anterior unpaired area the shortest; pores unigeminal, the poriferous zones clearly marked on the dorsal surface with the pore pairs nearly horozontal in position, but towards the ambitus the pores become smaller, those of each pair nearer together and the pairs obliquely situated at the lower, outer corner of each plate, near the margin of the oral opening they again become larger. Interambulacral areas wide, composed of large plates, the surface covered with irregular rows of small tubercles that are perforated and mammalated, the miliary space covered with numerous, minute, irregularly-crowded granules. Apical disk small, situated anteriorly; the four genital plates distinctly perforated, those of the anterior pair situated much nearer together than the posterior ones. Oral opening large, oblique, situated in front of the center of the ventral side. Anal opening supramarginal, large, oval, pointed at the upper extremity, situated in an anal sulcus that makes a marked indentation of the posterior margin and is bordered by two well-defined ridges.

The dimensions of a complete individual are: length, 25 mm.; width, 21.9 mm.; height, 14 mm.

Remarks.—This species is the only known American representative of the genus, and it is not closely allied to any of the European forms.

Formation and locality.—Vincentown limesand, Timber Creek (Clark).

Geographic distribution.—New Jersey.

Family CASSIDULIDAE.

Genus CATOPYGUS Agassiz.

Catopygus oviformis Conrad.

Plate XI., Figs. 10–15.

1847. *Catopygus oviformis* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 2, p. 39, pl. 1, fig. 9.
1868. *Nucleolites oviformis* Con., Cook's Geol. N. J., p. 722.
1891. *Catopygus oviformis* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 76.
1893. *Catopygus oviformis* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 52.
1893. *Catopygus oviformis* Clark, Bull. U. S. G. S., No. 97, p. 64, pl. 27, figs. 2 a-f.
1905. *Catopygus oviformis* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 7.

Description.—Test ovate, broader posteriorly, ventral side nearly flat, becoming slightly concave towards the margin of the oral opening, lobed posteriorly, the sides rounded and inflated, the dorsal surface somewhat flattened with the apex posterior to the apical disk. Ambulacral areas narrowly lanceolate, the two posterior ones being much longer than the others, subpetaloid on the upper surface where the plates are narrow, but beyond the petaloid portion the plates increase in width. Interambulacral areas wide, made up of large plates which are covered with minute tubercles, between which are numerous microscopic granules; the posterior interambulacrum elevated. Apical disk small, eccentric, situated far in front of the apex. Oral opening small, eccentric, situated towards the anterior margin. Anal opening oval, placed at the upper part of a nearly vertical anal sulcus, the upper margin of which forms a beak-shaped prominence overhanging the opening.

The dimensions of a complete individual are: length, 21.9 mm.; width, 18.75 mm.; height, 11 mm.

Formation and locality.—Vincentown limesand, Timber Creek (Clark).

Geographic distribution.—New Jersey.

Catopygus pusillus Clark.

Plate XI., Figs. 16–19.

1891. *Catopygus pusillus* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 76.

1893. *Catopygus pusillus* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 52.

1893. *Catopygus pusillus* Clark, Bull. U. S. G. S., No. 97, p. 65, pl. 27, figs. 3 a-d.

Description.—Test ovate to subquadrate, rounded in front and subtruncate behind, greatest width back of the middle, ventral surface concave, dorsal surface convex and somewhat elevated. Ambulacral areas narrowly lanceolate, subpetaloid on the dorsal surface, the posterior pair only slightly longer than the anterior. Interambulacral areas wide, composed of large plates. Apical disk small, nearly central. Oral opening small, situated eccentrically in front of the center of the ventral side. Anal opening oval, situated in a nearly vertical anal sulcus, its upper extremity overhung by a projecting arch.

The dimensions of a complete individual are: length, 15.6 mm.; width, 14 mm.; height, 6.5 mm.

Remarks.—This species has only been observed in the form of internal casts, so that the surface markings cannot be described, but they are, doubtless, similar to those of *C. oviformis*. The species can be distinguished from *C. oviformis* by its broader and slightly subquadrate form, its less rounded sides and the more nearly central position of the apical disk.

Formation and locality.—Merchantville clay-marl, near Matawan (101).

Geographic distribution.—New Jersey.

Catopygus williamsi n. sp. Clark.

Plate XII., Fig. 1–4.

Description.—Test ovate, slightly broader posteriorly, the posterior margin but little truncated; dorsal surface rounded and somewhat elevated, but not highly inflated; ventral surface con-

cave. Ambulacral areas subpetaloid on the dorsal surface, the posterior pair somewhat longer than the others. Apical disk highly eccentric, situated anterior to the apex. Oral opening small, situated eccentrically towards the anterior margin. Anal opening small, situated low down on the overhanging, slightly truncated posterior margin.

The dimensions of the type specimen are: length, 26 mm.; width, 22 mm.; height, 15 mm.

Remarks.—This species is quite distinct from either *C. oviformis* or *C. pusillus,* from both of which species it may be readily separated by the form of the posterior margin and by the position of the anal opening.

Formation and locality.—Navesink marl, bluff east of Atlantic Highlands (Clark).

Geographic distribution.—New Jersey.

Catopygus sp. undet.

A poorly preserved specimen of a species of *Catopygus* from the Tinton beds presents some similarity to *C. pusillus,* but in its imperfect state of preservation it cannot be with certainty assigned to that species. Some of the most important diagnostic characters are lacking.

Formation and locality.—Tinton beds. Beers Hill Cut, south of Keyport (129[5]).

Genus Cassidulus Lamark.

Cassidulus aequoreus Morton.

Plate XII., Figs. 5–12.

1834. *Cassidulus æquoreus* Morton, Synop. Org. Rem. Cret. Gr. U. S., p. 76, pl. 3, fig. 14.
1864. *Cassidulus æquoreus* Meek, Check List Inv. Foss. N. A. Cret. and Jur., p. 2.
1868. *Cassidulus æquoreus* Conrad, Cook's Geol. N. J., p. 722.
1891. *Cassidulus æquoreus* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 76.

1893. *Cassidulus æquoreus* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 52.

1893. *Cassidulus æquoreus* Clark, Bull. U. S. G. S., No. 97, p. 68, pl. 29, figs. 1 a-i.

1905. *Cassidulus æquoreus* Johns., Proc. Acad. Nat. Sci. Phil. 1905, p. 7.

Description.—Test subpentagonal, depressed conical, longer than wide. Ambulacral areas narrow, poriferous zones unigeminal; petaloid on the upper part of the dorsal surface at a point varying in the different areas from one-quarter to one-third of the distance from the margin to the apical system, the zones are contracted and continue as narrow bands over the margin and to the vicinity of the peristome, where they broaden again perceptibly, becoming finally much contracted at the margins of the oral opening. The pores are distinct in the petaloidal portion and in the broadened area near the peristome, but in the intermediate contracted portion they are small and indistinct. Interambulacral areas broad, covered by small perforated tubercles with sunken areolas. The apex forward of the center, the apical system composed of four perforated genital and five small radial plates; the fifth genital obsolete. The peristome pentagonal, surrounded by a well-developed floscelle; the oral lobes very prominent and the ambulacral furrows much contracted. The anal opening is situated in a short sulcus on the upper surface.

The dimensions of a complete individual are: length, 31.25 mm.; width, 28.12 mm.; height, 15.6 mm.

Remarks.—This species may be separated from *C. florealis* (Morton) by its more depressed and elongate form. From *C. micrococcus* it is separated by its sharper apex, more angular margin, the position of the periproct, and the shorter pore openings in the outer row.

Formation and locality.—Navesink marl, bluff east of Atlantic Highlands (Clark).

Geographic distribution.—New Jersey, Alabama.

Family ANANCHYTIDAE.

Genus ANANCHYTES Mercati.

Ananchytes ovalis Clark.

Plate XIII., Figs. 1–8.

1893. *Ananchytes ovalis* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 52.

1893. *Ananchytes ovalis* Clark, Bull. U. S. G. S., No. 97, p. 74, pl. 36, figs. 1 a-h.

Description.—Test subovate, somewhat pointed posteriorly, ventral side nearly flat, curving inward to the oral opening, with a rounded ridge joining the anal and oral openings; the sides full and rounded at the ambitus, the dorsal surface convex. Ambulacral areas broad and flat, attaining their greatest width just above the ambitus, the pores subelliptical in outline, the longer axes of those of each pair directed at an angle to each other. Interambulacral areas broad. The surface of both ambulacral and interambulacral plates covered with small tubercles, between which are numerous microscopic granules. Apical disk situated slightly in front of the center, elongate; the four genital plates large and distinctly perforate, the right anterior one, which serves as the madreporite, is much larger than any of the others, being several times the size of the left anterior one with which it is in contact, the posterior ones of nearly equal size. Oral opening transversely subelliptical, situated near the anterior margin. Anal opening oval, situated on a marked protuberance on the posterior margin.

The dimensions of a complete individual are: length, 43.75 mm.; width, 37.5 mm.; height, 31.25 mm.

Remarks.—This species is the only known American representative of the genus, and it differs from the European species in its more ovate and less elevated form.

Formation and locality.—Vincentown limesand, Vincentown (Clark).

Geographic distribution.—New Jersey.

Genus Cardiaster Forbes.

Cardiaster cinctus (Morton).

Plate XIV., Figs. 1–8.

1829. *Spatangus* sp. Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol 6, p. 122.
1830. *Ananchytes* sp. Mort., Am. Jour. Sci., 1st ser., vol. 17, p. 287.
1830. *Ananchytes cinctus* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 200.
1830. *Ananchytes fimbriatus* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol 6, p. 200.
1830. *Ananchytes cinctus* Mort., Am. Jour. Sci., 1st ser., vol. 18, p. 246, pl. 3, fig. 7.
1830. *Ananchytes fimbriatus* Mort., Am. Jour. Sci., 1st ser., vol. 18, p. 245, pl. 3, fig. 9.
1834. *Ananchytes cinctus* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 78, pl. 3, fig. 19.
1834. *Ananchytes fimbriatus* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 78, pl. 3, fig. 20.
1855. *Cardiaster fimbriatus* d'Orb.' Pal. Franc., Terr. Cret., p. 146, pl. 905, fig. 3.
1855. *Cardiaster cinctus* d'Orb., Pal. Franc., Terr. Cret., vol. 6, p. 147, pl. 905, fig. 4.
1870. *Holaster cinctus* Credner, Zeitsch. d. Deutsch. Geol. Gesell., vol. 22, p. 218.
1891. *Holaster cinctus* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 77.
1893. *Cardiaster cinctus* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 52.
1893. *Cardiaster cinctus* Clark, Bull. U. S. G. S., No. 97, p. 75, pl. 37, figs. 1 a-h.
1905. *Cardiaster fimbriatus* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 7.
1905. *Cardiaster fimbriatus* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 7.

Description.—Test distinctly cordate, with a pronounced sulcus anteriorly occupied by the anterior ambulacral area, the posterior extremity somewhat pointed; the lower surface nearly flat except for the slight depression towards the margins of the oral opening, and a rounded, ridge-like elevation extending from the center to the posterior margin; dorsal surface convex, curving downward to the ambitus which is near the base, the regular curvature of the surface interrupted by the strong anterior sulcus and by a slight ill-defined ridge which passes posteriorly from the apical disk to the vertically truncated surface of the posterior margin. Ambulacral areas broad, not petaloid, separated at the apex; the antero-lateral pair curving slightly forward and the postero-lateral pair slightly backward in their proximal portion, beyond which they extend straight to the margin; the unpaired anterior ambulacrum occupying the deep anterior sulcus; the pores of the paired ambulacra consist, in the upper portion of the series, of oblique oval openings united by furrows, while lower down they become small and indistinct; in the anterior ambulacrum the pores are extremely small. Interambulacra broad, consisting of large plates. Surface of all the plates covered with fine granules, among which are numerous, small, perforated, irregularly scattered tubercles. Apical disk slightly in front of the center, narrow and elongate, the four perforated genital plates arranged in pairs; the five ocular plates are arranged in two pairs and one single plate, one of the pairs between the two pairs of genital plates, the other situated posteriorly and the single plate anteriorly placed. The oral opening is transversely subelliptical, situated near the anterior margin of the ventral surface. Anal opening subovate, situated upon the truncated surface at the posterior margin of the test.

The dimensions of a complete individual are: length, 50 mm.; width, 50 mm.; height, 28.12 mm.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek (Clark).

Geographic distribution.—New Jersey.

Cardiaster smocki n. sp. Clark.

Plate XIII., Figs. 9–11.

Description.—Test small, cordate, distinctly elevated, the dorsal surface strongly convex, the ventral surface flat. The anterior ambulacral sulcus is very pronounced and the opposite ridge in the unpaired posterior interambulacrum is well shown but is sharply cut off by the nearly vertically truncated surface of the posterior margin. The sides slope rapidly to the ambitus. Ambulacral areas wide, apetaloid and well separated at the apex; antero-lateral pair bent backward above, beyond which they extend straight to the ambitus; the posterior-lateral pair are bent slightly forward at first and then continue in a straight line over the margin; the unpaired ambulacrum situated on the deep anterior sulcus. Apical system much elongated, widely separating the ambulacral areas. The peristome transversely oval, situated anteriorly.

The dimensions of the type specimen are: length, 18.5 mm.; width, 17.5 mm.; height, 10 mm.

Remarks.—This species is most closely related to *Cardiaster cinctus,* but it is a smaller form with somewhat less pronounced anterior sulcus and more inflated test.

Formation and locality.—Merchantville clay-marl. (Clark.)

Geographic distribution.—New Jersey.

Family SPATANGIDAE.

Genus HEMIASTER Desor.

Hemiaster parastatus (Morton).

Plate XV., Figs. 1–13.

1830. *Spatangus* sp. Mort., Am. Jour. Sci., 1st ser., vol. 17, p. 286.

1830. *Spatangus cor-marinum* (?) Mort., Am. Jour. Sci., 1st ser., vol. 18, p. 250, pl. 3, fig. 10.

1830. *Spatangus cor-marinum* (?) Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 199.

1833. *Spatangus parastatus* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 294.
1834. *Spatangus parastatus* Mort. Synop. Org. Rem. Cret. Gr. U. S., p. 77, pl. 3, fig. 21.
1853. *Hemiaster parastatus* Marcou, Explan. Text to Geol. Map U. S. and Brit. Prov. N. A., p. 47, pl. 7, fig. 8.
1855. *Hemiaster parastatus* d'Orb., Pal. Franc., Terr. Cret., vol. 6, p. 265, pl. 894, fig. 4.
1864. *Hemiaster* (?) *parastatus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1891. *Hemiaster parastatus* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 77.
1893. *Hemiaster parastatus* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 52.
1893. *Hemiaster parastatus* Clark, Bull. U. S. G. S., No. 97, p. 83, pl. 45, figs. 1 a-m.
1905. *Hemiaster parastatus* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 7.

Description.—Test distinctly cordate, the ventral surface flat with the exception of the peristomal depression, the sides rounded and inflated laterally and in front, the posterior side high and nearly vertically truncated, the dorsal surface convex, greatly elevated towards the posterior margin and with a distinct, deep, anterior sulcus. Ambulacral areas dissimilar, petaloid, with the petals depressed, those of the postero-lateral pair short and broad, those of the antero-lateral pair curving forward and about twice the length of the postero-lateral pair, the anterior, unpaired ambulacrum very broad, with the poriferous zones far apart and the pores small and approximated. Interambulacral areas broad, composed of large plates. Surface of all the plates covered with small tubercles between which are numerous microscopic granules; the peripetalous fasciole broad and distinct. Apical disk small, compact, posterior to the center of the dorsal surface but in front of the apex of the test, the four genital plates distinctly perforated and separated by the five small oculars. Oral opening transversely arched, bilabiate, with a distinct, overhanging lip. Anal opening small, situated high on the truncated posterior side.

The dimensions of a complete example are: length, 37.5 mm.; width, 37.5 mm.; height, 28.12 mm.

Remarks.—This species is most closely related to *H. ungula*, from which it may be separated by its deeper and broader anterior sulcus, more posterior position of the apical disk, and its more inflated sides.

Formation and locality.—Vincentown limesand, Vincentown and Timber Creek (Clark).

Geographic distribution.—New Jersey, Alabama.

Hemiaster stella (Morton).

Plate XVI., Figs. 1–4.

1830. *Spatangus stella* Mort., Am. Jour. Sci., 1st ser., vol. 18, p. 245, pl. 3, fig. 11.
1830. *Spatangus stella* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 200.
1834. *Spatangus stella* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 78, pl. 3, fig. 18.
1864. *Hemiaster stella* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1891. *Hemiaster incrassatus* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 77.
1893. *Hemiaster stella* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 52.
1893. *Hemiaster stella* Clark, Bull. U. S. G. S., No. 97, p. 84, pl. 46, figs. 1 a-d.
1905. *Hemiaster stella* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 7.

Description.—Test small, ovate, inflated, rounded in front and truncated behind, the ventral surface nearly flat, the dorsal surface convex, strongly elevated near the posterior margin, sloping anteriorly and lacking a distinct anterior sulcus. Ambulacral areas petaloid, with the petals straight and depressed, the antero-lateral pair twice as long as the postero-lateral pair, and the unpaired anterior one longer than those of the antero-lateral pair. Interambulacral areas broad, composed of large plates. Surface

of the test covered with innumerable small tubercles, between which are microscopic granulations; the peripetalous fasciole distinct, oval, passing with a regular curve about the extremities of the petaloid areas. Apical disk small, situated posterior to the center of the dorsal surface but in front of the apex of the test. Oral opening transversely subelliptical, bilabiate, situated near the anterior margin. Anal opening small, oval, situated at the upper part of the posterior truncated surface.

The dimensions of a complete individual are: length, 25 mm.; width, 21.9 mm.; height, 15.6 mm.

Remarks.—This species may be easily distinguished from other American members of the genus by reason of its short anterior sulcus which terminates before reaching the margin, so that the anterior margin of the test is not emarginate.

Formation and locality.—Vincentown limesand, Timber Creek (Clark).

Geographic distribution.—New Jersey.

Hemiaster ungula (Morton).

Plate XVI., Figs. 5–11.

1830. *Spatangus* sp. Mort., Am. Jour. Sci., 1st ser., vol. 17, p. 286.

1833. *Spatangus ungula* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 131, pl. 10, fig. 6.

1834. *Spatangus ungula* Mort., Synop. Org. Rem. Cret. Gr. U S., p. 78, pl. 10, fig. 6.

1891. *Hemiaster ungula* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 77.

1893. *Hemiaster ungula* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 52.

1893. *Hemiaster ungula* Clark, Bull. U. S. G. S., No. 97, p. 85, pl. 46, figs. 2 a-g.

1905. *Hemiaster ungula* Johns. Proc. Acad. Nat. Sci. Phil., 1905, p. 7.

Description.—Test ovate, distinctly cordate, the ventral surface flat, except the peristomal depression, the dorsal surface

greatly elevated posteriorly, sloping rapidly to the front, with a narrow and deep anterior sulcus and a sharp ridge at the posterior median line terminated by the nearly vertical truncation of the posterior side, lateral and anterior sides rounded. Ambulacral areas petaloid, narrow, the petaliferous portion straight and deeply impressed, the antero-lateral pair twice as long as the postero-lateral ones; the pores of the paired ambulacra elongated and separated, those of the single ambulacra small, oval and approximated. Interambulacral areas broad, composed of large plates. Surface of the test covered with small tubercles, between which are numerous minute granules; the peripetalous fasciole distinct and bent strongly inward between the anterior and posterior-paired ambulacra. Apical disk small, situated posterior to the center of the dorsal surface and anterior to the point of greatest elevation of the test; the antero-lateral genital plate very large and widely separating the posterior pair of oculars, the postero-lateral genitals with large perforations. Oral opening transversely subelliptical, bilabiate, with a prominently projecting lower lip. Anal opening large, situated at the upper part of the truncated face of the posterior margin.

The dimensions of a complete example are: length, 31.25 mm.; width, 28 mm.; height, 21.9 mm.

Remarks.—This species may be easily distinguished from *H. parastatus* by its narrower anterior sulcus, its more nearly central apical disk, its sharper posterior keel, its straight ambulacral areas, and by its more deeply incurved peripetalous fasciole between the paired ambulacra.

Formation and locality.—Vincentown limesand, Timber Creek (Clark).

Geographic distribution—New Jersey.

Hemiaster welleri n. sp. Clark.

Plate XVII., Figs. 4-6.

Description.—Test cordiform, inflated, dorsal surface only slightly elevated posteriorly, ventral surface flat, sides rounded. Anterior sulcus broad and clearly defined, not deeply indenting the anterior ambitus; the posterior ridge not greatly accentuated,

terminating in a well-defined, truncated posterior surface. Ambulacral areas moderately depressed in the petaloid portions; the postero-lateral pair considerably shorter than the antero-lateral, although the difference is less marked than in other New Jersey Cretaceous species of the genus; the anterior ambulacrum situated in a broad, shallow groove that largely disappears before the ambitus is reached. Apical system small, imperfectly shown on the casts. Peristome of moderate size with distinct overhanging lip. Periproct small, situated high on the truncated posterior surface.

The dimensions of the type specimen are: length, 27 mm.; width, 24 mm.; height, 17 mm.

Remarks.—This species is related to *H. parastatus,* from which, however, it is separated by its less deeply depressed ambulacral furrows and less elevated dorsal surface. It also shows points of resemblance to *H. kümmeli,* from which, however, it is separated by its longer postero-lateral ambulacral petals and less elevated posterior ridge on the dorsal surface.

Formation and locality.—Merchantville clay-marl, near Jamesburg (139,141), Lenola (163); Navesink marl, bluff east of Atlantic Highlands (Clark).

Geographic distribution—New Jersey.

Hemiaster kümmeli n. sp. Clark.

Plate XVII., Fig. 1–3.

Description.—Test cordate, rather large, slightly elevated, the dorsal surface nearly flat, ventral surface flat. The posterior interambulacrum nearly flat with a low truncated posterior surface. Ambulacral areas pronounced, with weakly depressed petaloid areas; the petals of the postero-lateral pair relatively long and narrow; less than twice the length of the antero-lateral pair; the unpaired ambulacrum not deeply depressed, and not forming a pronounced sulcus on the anterior margin. The apical system small, not as strongly eccentric as in some of the other Cretaceous species. Peristome with a distinct overhanging lip, the periproct not seen.

The dimensions are: length, 30-50 mm.; width, 30-40 mm.; height, about 20 mm.

Remarks.—This species is represented by numerous flattened casts, none of which show clearly the original form of the test, although it is apparently somewhat flatter than the other New Jersey Cretaceous members of the genus. The species is related to both *Hemiaster parastatus* and *H. welleri.* From the former it is separated by its shallower and narrower ambulacral petals and less elevated form; from the latter by its longer and narrower postero-lateral ambulacral petals and flatter form.

Formation and locality.—Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey.

Genus LINTHIA Merian.

Linthia tumidula Clark.

Plate XVIII., Figs. 1–9.

1891. *Linthia tumidula* Clark, Johns Hopkins Univ. Circ., vol. 10, No. 87, p. 77.

1893. *Linthia tumidula* Clark, Johns Hopkins Univ. Circ., vol. 12, No. 103, p. 52.

1893. *Linthia tumidula* Clark, Bull. U. S. G. S., No. 97, p. 91, pl. 50, figs. 1 a-i.

Description.—Test ovate, distinctly cordiform, the ventral surface flat except for the peristomal depression, the dorsal surface elevated, with flattened, sloping sides, a moderately impressed anterior sulcus which produces the emargination of the anterior margin, and a distinct anterior median keel. Ambulacral areas straight, narrow, impressed to a moderate depth for a long distance upon the dorsal surface, the anterior-lateral pair one and one-half times as long as the postero-lateral pair; the poriferous zones broad and straight, the pores large and oval, those of each pair connected by a shallow furrow. Interambulacral areas broad, composed of large plates. Surface of the test covered with minute, perforated tubercles that are much larger on the ventral than on the dorsal surface, between the tubercles the surface is covered with microscopic granulations; both the peripetalous and the lateral fascioles clearly defined. Apical disk small, nearly

central, slightly depressed. Oral opening transversely subelliptical, situated near the anterior margin. Anal opening small, subelliptical, situated but a short distance above the posterior margin.

The dimensions of a complete individual are: length, 53 mm.; width, 50 mm.; height, 28 mm.

Remarks.—This species is the only known American representative of this genus, and it is not closely allied to any of the European species.

Formation and locality.—Vincentown limesand, Timber Creek (Clark).

Geographic distribution.—New Jersey.

CHAPTER IV.

Branch VERMES.

Class ANNELIDA.

Sub-Class CHAETOPODA.

Order POLYCHAETA.

Sub-order TUBICOLA.

Genus SERPULA Linneus.

Serpula circularis n. sp.

Plate XIX., Figs. 5–6.

Description.—Tube rather large, moderately thick, increasing gradually in size, the increase being more rapid as it approaches the aperture, not closely coiled, the first volution of the type specimen forming a rather large irregular circle, after which the shell is in contact for about one-fourth volution nearly to the aperture. Another specimen is perhaps not in contact at all. Aperture more or less subcircular or subelliptical in outline. The surface of the shell is marked by more or less irregular, annular lines of growth.

The dimensions of the type species are: greatest diameter of aperture 8 mm.; length of tube, 72 mm.; greatest diameter of space within first volution, 13 mm.

Remarks.—The type specimen is the only individual observed which is anywhere near complete, though other fragments indicate that the large open coiling of the tube was a common habit of growth. The type has apparently been attached to some large shell, probably a *Gryphaea,* during life, by the flatter side, although in its present condition it is free.

Formation and locality.—Marshalltown clay-marl. Near Swedesboro (177).

Geographic distribution.—New Jersey.

Serpula whitfieldi n. sp.

Plate XIX., Fig. 2.

1892. *Diploconcha (Serpula?) cretacea* ? Whitf., Pal. N. J., vol. 2, (Monog. U. S. G. S., vol. 18), p. 170, pl. 20, fig. 25. (Not *Diploconcha cretacea* Con.)

Description.—Tubes irregularly arcuate, slightly flexuose, increasing in diameter very gradually; surface of shell lamellose where partially exfoliated, in cross-section appearing to be made up of concentric lamellæ.

The dimensions of the largest tube observed are: total length, 70 mm., maximum diameter, 6.5 mm.

Remarks.—The type specimen consists of several more or less complete calcareous tubes which are attached to the surface or penetrate the substance of some thick pelecypod shell. The two largest tubes, the ones illustrated by Whitfield, lie in a position essentially parallel with one another, and besides these there is another apparent pair of smaller tubes upon another surface of the specimen. Because of their apparent occurrence in pairs, Whitfield identified this specimen with *Diploconcha cretacea* Con., but they differ from that species in not having the tubes in contact in any portion of the specimen as preserved, and in having a rather heavy and thick shell. This apparent occurrence in pairs, however, is probably accidental rather than fundamental, since other individuals are present upon the specimen which give no evidence of being in pairs, although it must be said that the unpaired individuals are less complete than those in pairs. The tubes have much the appearance of the tubes of *Teredo,* but no evidence of the presence of a bivalve shell has been seen.

Formation and locality.—Navesink marl, Crosswicks Creek (Whitfield).

Geographic distribution.—New Jersey.

Serpula rotula (Morton).

Plate XIX., Figs. 8–10.

1834. *Vermetus rotula* Morton, Synop. Org. Rem. Cret. Gr. U. S., p. 81, pl. 1, fig. 14.

1861. *Spirorbis rotula* Gabb, Synop. Moll. Cret. Form., p. 148.

Description.—Shell usually discoid and flattened, attached by the initial portion of the tube only, with three or four subquadrangular volutions in contact throughout except rarely for a short distance near the aperture; the initial portion of the tube, at the point of attachment is somewhat irregular, the outer volutions much more regular, coiling either dextrally or sinistrally; the side opposite the point of attachment more or less umbilicate. The periphery of the shell bicarinate, the sides of the volutions with a broad, shallow, rounded, longitudinal depression or furrow. Aperture subcircular, although the external outline of the tube is quadrangular, due to the thickening of the shell at the corners.

The dimensions of a rather large individual are: diameter, 9 mm.; thickness, 1.2 mm.

Remarks.—This little spirally coiled worm tube is not uncommon in the Vincentown limesand. It usually occurs entirely free, although the side by which it has been attached may always be recognized by the fracturing of the initial portion of the shell. All those specimens which have been observed attached to other objects, have been attached to various species of bryozoans. The tubes are coiled indifferently to the right or to the left from the point of attachment, the numbers of sinistral and dextral individuals being about equal.

Formation and locality.—Vincentown limesand, Vincentown. (154), Medford (161), near Hurffville (170).

Geographic distribution.—New Jersey.

Genus HAMULUS Morton.

Hamulus falcatus (Conrad).

Plate XXII., Figs. 11–12.

1869. *Dentalium falcatum* Con., Am. Jour. Conch., vol. 5, p. 44, pl. 1, figs. 12 and 16.
1870. *Falcula hamatus* Con., Am. Jour. Conch., vol. 6, p. 77.
1892. *Dentalium* (*Falcula*) *falcatum* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 169, pl. 20, figs. 12-18.
1905. *Hamulus falcatus* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Internal casts small, cylindrical, gradually tapering and strongly curved with a decreasing curvature as they increase in size, the smaller extremity being much more curved than the larger parts.

The dimensions of an average individual are: length of tube, 28 mm.; larger diameter, 2.8 mm.; smaller diameter, 1.1 mm.

Remarks.—This species is known only from internal casts, and is quite probably not distinct from *H. squamosus* Gabb,[1] an Alabama species described from the shell itself. A single individual from the Marshalltown clay-marl has been observed upon which a portion of the shell is preserved, which shows the same longitudinal folds present in the Alabama specimens.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177); Navesink marl, various localities.

Geographic distribution.—New Jersey, Alabama.

Hamulus lineatus n. sp.

Plate XIX., Fig. 7.

Description.—Internal casts of tubes cylindrical, nearly straight or slightly curved, smooth, increasing very gradually in size.

The dimension of a nearly straight specimen, probably incomplete, are: length, 53 mm.; greater diameter, 3.6 mm.; lesser diameter, 2.5 mm.

Remarks.—The specimens to which this name is here applied are the casts of certain more or less straight tubes found commonly in the Merchantville and Navesink formations. In hand specimens these objects are not unlike casts of burrows of habitation of some annelid worm, but unlike such burrows they lie parallel with the bedding of the strata and not vertical to it. No trace of the shell substance itself, of the tubes, has been observed, the specimens being identical in lithologic character with the numerous internal casts of gastropods with which they are associated. Some of the individuals resemble the internal casts of *Dentalium arcuatum*, but they taper less rapidly than that species, and are straighter or less regularly arcuate.

[1] Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 398, pl. 68, fig. 45 (1860).

Formation and locality.—Merchantville clay-marl, Lenola (163), near Jamesburg (140); Navesink marl, near Crawfords Corner (126[7]), etc.

Geographic distribution.—New Jersey.

Hamulus ?? sp.

Plate XIX., Figs. 3–4.

A single fragmentary specimen of a probable worm tube from the Wenonah sand differs from any others in the collection, and cannot be identified with any described species. The internal cast is cylindrical and straight, with the sides very gradually diverging from the smaller to the larger extremity. A squeeze of the impression of the outside of the tube shows it to be marked with distinct, rounded, annular ribs.

The dimensions of the fragment observed are: length, 25 mm.; greater diameter of internal cast, 9 mm.; lesser diameter of same, 8 mm.

The species differs from the cylindrical bodies here described as *Hamulus lineatus* in its much greater size, but the external characters of that species are unknown.

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey.

Worm burrow.

Plate XIX., Fig. 1.

In one bed of the Tinton formation at Beers Hill cut, south of Keyport, there are large numbers of more or less vertical, straight or slightly curved cylindrical bodies with parallel sides, usually from 12 to 15 mm. in diameter, and attaining a maximum length of about one foot. These bodies are probably the casts of the burrows of some organism, probably one of the segmented worms.

Formation and locality.—Tinton beds, Beers Hill Cut (129[8]).

Geographic distribution.—New Jersey.

CHAPTER V.

Branch MOLLUSCOIDEA.

Class BRYOZOA.

Order CYCLOSTOMATA.

Family DIASTOPHORIDAE.

Genus STOMATOPORA Bronn.

Stomatopora regularis Gabb & Horn.

Plate XX., Figs. 1–3.

1862. *Stomatopora regularis* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 172, pl. 21, fig. 63 (fig. 64 on plate).

1864. *Alecto regularis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.

1868. *Alecto regularis* Con., Cook's Geol. N. J., p. 723.

1905. *Alecto regularis* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium encrusting, ramose, the branches filiform and usually very regular, from .4 mm. to .6 mm. in width, the surface slightly convex, the sides sloping gently towards the lateral margins, rarely or never abrupt. Zoœcia regular in shape, usually a little wider just behind the aperture and the sides converging slightly posteriorly, this difference in width, however, is frequently scarcely noticeable and is never sufficient to sharply separate the successive zoœcia from each other. Zoœcial apertures circular, tubular and inclined a little forward in unworn specimens.

Remarks.—This species will not be easily confused with any of its associates, except possibly *Filifascigera megaera,* and from this species it can always be distinguished by the single circular aperture of the zoœcial tubes.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Stomatopora kümmeli Ulrich and Bassler n. sp.

Plate XX., Fig. 4.

Description.—Zoarium encrusting, ramose, the branches very fine and delicate, from .15 mm. to .2 mm. in width, the surface transversely convex, the slope from center to lateral margins never abrupt. Zoœcia regular in form, scarcely differentiated, although the sides converge slightly posteriorly. Zoœcial apertures circular, in unworn specimens, with the rim slightly elevated and inclined a little forward.

Remarks.—This species is a very close ally of *S. regularis,* but may be distinguished from that species by its much more delicate growth in every way.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Stomatopora temnichorda Ulrich and Bassler n. sp.

Plate XX., Figs. 5–6.

Description.—Zoarium adnate, frequently branching, conconsisting of uniserially-arranged zoœcia. Zoœcia elongate-pyriform, or club-shaped, .45 mm. to .75 mm. in length, about .02 mm. in width at the posterior extremity, increasing very gradually in size through about one-half their length, and then somewhat abruptly to about .15 at the rounded anterior end. Zoœcial aperture nearly terminal, small, circular, with a slightly elevated, rim-like border, from .035 mm. to .05 mm. in diameter.

Remarks.—This exceedingly delicate little species belongs with a group of forms typified by *S. inflata* of the Ordovician faunas. It may be readily recognized by its exceedinly fine and elongate zoœcia.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Genus BERENICEA Lamark.

Berenicea americana Ulrich and Bassler n. sp.

Plate XX., Fig. 7.

Description.—Zoarium incrusting, growing in more or less irregular patches upon the surfaces of other bryozoa. Zoœcia contiguously arranged in more or less regular spreading series, each zoœcium about .5 mm. in length and from .1 mm. to .13 mm. in width, the lateral boundaries sharply defined by impressed grooves, the surface gently convex transversely. Zoœcial apertures nearly terminal, circular, a little narrower than the zoœcia, directed slightly forward, with a slightly elevated rim-like border.

Remarks.—This species cannot be confused with any associated bryozoan, the other American species of the genus being mainly of Ordovician age. The species is particularly characterized by its small, narrow, elongate zoœcia, with each zoœcium sharply marked laterally.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Genus DISCOSPARSA d'Orbigny.

Discosparsa varians Ulrich.

Plate XXI., Figs. 1–2.

1901. *Discosparsa varians* Ulrich, Md. Geol. Surv., Eocene, p. 205, pl. 59, fig. 3.

Description.—"Zoarium forming subcircular (young) or irregular, undulating expansions, 2 to 10 mm. wide, parasitically attached, or more or less free and epithecated beneath. In young colonies which are often spread over the original layer, the zoœcial apertures, which are enclosed by moderately elevated, ring-like peristomes, are, sometimes uniserially, but never very regularly, arranged in a radial manner about the small, depressed and smooth central space. In older examples, there are

several of these maculæ, but the radial arrangement of the zoœcia about them, is generally obscure. The zoœcia immediately surrounding the maculæ are often of larger size and more oblique than those covering the intermediate spaces where they are quite direct, but in worn examples very little difference in size is noticeable. The interzoœcal spaces, which are solid and concave normally, are pitted in worn specimens as though they contained covered mesopores or vesicles. The unworn covering is minutely punctate, as are also the covers closing some of the zoœcal apertures. The zoœcia form mere inflations of the surface, usually (perhaps always) over one of the maculæ, which in that case is slightly raised instead of depressed and pierced by somewhat scattered apertures. An average of nine zoœcia occur in 2 mm. Tube walls as seen in fractured specimens, thin beneath the outer crust, minutely perforated, the pores arranged in transverse series with nearly three of the rows in the space equalling the width of a tube. No diaphragms were observed. Length of tubes, 1 mm. or less." (Ulrich.)

Remarks.—This species was originally described from the Eocene of Maryland, although the Vincentown examples were referred to the species at the same time. In some of the Vincentown specimens the maculæ are scarcely so noticeable as in the Eocene examples, but others agree very closely with those from Maryland. The completely attached colonies have essentially the characters of the genus *Berenicea,* but this species is often more or less free with the lower surface covered with an epitheca.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey; also in Eocene of Maryland.

Genus DIASTOPORA Lamark.

Diastopora lineata Gabb & Horn.

Plate XXI., Figs. 3–4.

1862. *Diastopora lineata* G. &. H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 172, pl. 21, fig. 62.

1864. *Diastopora lineata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.
1868. *Diastopora lineata* Con., Cook's Geol. N. J., p. 723.
1905. *Diastopora lineata* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium encrusting at the base, afterwards rising in an enrolled plate or tortuous, branched tube with thin walls and a diameter of from 1 to 2 mm. The back of the zoarium in the tubular portion, or the inner surface of the tubes, covered with an irregularly striated epitheca. Zoœcia small, the apertures circular and slightly elevated above the general surface, about .25 mm, or a little less in diameter, arranged more or less irregularly but frequently with a quincuncial tendency, the spaces between the apertures being from one to five times their diameter; the immersed portion of the zoœcia often distinctly rounded and bounded on each side by a depressed line, sometimes with a median longitudinal rib and one or two lateral ones on each side; behind the aperture the surface usually slopes regularly to the common surface of the zoarium.

Remarks.—As it usually occurs, this species is represented by broken portions of the tubular parts of the zoarium, the basal incrusting portion being less common. Specimens of this character can be easily recognized by the thin walled tubes whose inner surface is covered by the irregular, annular striations of the epitheca.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Family IDMONEIDAE.

Genus RETICULIPORA d'Orbigny.

Reticulipora sagena Gabb & Horn.

1860. *Reticulipora sagena* G. & H., Proc. Acad. Nat. Sci. Phil., 1860, p. 366.
1860. *Reticulipora sagena* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 400, pl. 69, figs. 30-32.

1862. *Reticulipora sagena* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 173.
1864. *Reticulipora sagena* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.
1868. *Reticulipora sagena* Conrad, Cook's Geol. N. J., p. 723.
1905. *Reticulipora sagena* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—Zoarium consisting of broad, irregularly anastomosing branches whose sides are parallel or a little diverging towards the top, the upper surface of the branches subcarinate along the median line, the surface rounding from the base of the median carina into the sides. Zoœcia crowded, large, subangular, the dividing walls thick.

Remarks.—This is one of the rare species in the Vincentown fauna, only the type specimen having been seen.

Formation and locality.—Vincentown limesand, Timber Creek (Gabb and Horn).

Geographic distribution.—New Jersey.

Reticulipora dichotoma Gabb & Horn.

Plate XXI., Figs. 5–14.

1862. *Reticulipora dichotoma* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 173, pl. 21, fig. 64.
1864. *Reticulipora dichotoma* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.
1868. *Reticulipora dichotoma* Con., Cook's Geol. N. J., p. 723.
1901. *Reticulipora dichotoma* Ulrich, Md. Geol. Surv., Eocene, p. 207, pl. 59, figs. 9-12.
1905. *Reticulipora dichotoma* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—Zoarium not reticulated, consisting of laterally compressed, anteriorly carinate and posteriorly rounded branches whose height or width is 1 to 2 mm., with a thickness of about one-half the height; these branches give rise to similar branches laterally and occasionally bifurcate. Zoœcia crowded in front

towards the anterior carina and arranged in more or less irregular transverse series, about five or six occupying the space of 1 mm.; posteriorly they become more scattered and may become entirely wanting upon the rounded posterior surface. Zoœcial apertures subcircular or oval, slightly oblique, surrounded by a slightly raised peristone which is a little higher behind than in front. Smaller mesopores occupy the spaces between the zoœcia.

Remarks.—Besides its occurrence in the Vincentown limesand, this species has also been recognized in the Eocene of Maryland. A very similar, perhaps identical, form from the Upper Cretaceous (Senonien) of France has been described under the name *Bicrisina gaudryana* Pergens.[1]

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek (Gabb and Horn).

Geographic distribution.—New Jersey, also Eocene of Maryland.

Genus Crisina d'Orbigny.

Crisina striatopora Ulrich.

Plate XXI., Figs. 15–18.

1904. *Crisina striatopora* Ulrich, Md. Geol. Surv. Miocene, p. 406, pl. 117, figs. 1-4.

Description.—"Zoarium erect, ramose, probably not exceeding 1 cm. in height, dividing dichotomously at intervals of about 1.5 mm.; branches subovate in cross-section, thickest uniformly convex and traversed longitudinally by from 16 to 20 punctate striae on the reverse side, narrower and carrying alternating series of zoœcial apertures on the obverse side. Zoœcial apertures rarely three usually four in each series, in contact laterally, the inner one of each series largest, most prominent, and subcircular, the outer one, smallest, drawn out distally and apparently grading into the pores lying between the longitudinal ridges of the reverse side. Series of zoœcia curving first forward then slightly backward, separated by a deep interspace averaging

[1] Bull. Soc. Belg. de Geol., vol. 3, pl. 13, fig. 2.

about 0.2 mm. in width; about five rows in 2.0 mm. Over the basal part of the zoarium the zoœcial apertures are covered one after the other by the growth of the striato-punctate dorsal integument." (Ulrich.)

Remarks.—"This handsome species is readily distinguished from all others known to us having the character of *Crisina,* by the frequent dichotomization of the branches. Differences in cross-sections of the branches and in other respects are to be observed when compared with most of the species." (Ulrich.)

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey, also Miocene of Maryland.

Genus BISIDMONEA d'Orbigny.

Bisidmonea gabbiana Ulrich and Bassler n. sp.

Plate XXII., Figs. 1–2.

Description.—Zoarium with dichotomously dividing branches more or less quadrangular in cross-section, from .8 mm. to 3 mm. in thickness, carrying four series of zoœcial apertures the extremities of which upon the angles of the branches are either alternate or opposite. Zoœcial apertures three to five in each series in contact laterally, subcircular, decreasing in size from the outside to the center of each series. The series of zoœcia curving toward the growing ends of the branches with a gentle, convex cirvature.

Remarks.—Only the broken fragments of branches of this species have been observed, the entire zoarium, however, was probably small. The species is distinctly different from any of the associated bryzoa and can be easily recognized by its typically quadrangular branches, each of the four faces of which bear a series of curved, transverse rows of zoœcial apertures.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Genus IDMONEA Lamark.

Idmonea abbotti Gabb & Horn.

Plate XXII., Figs. 3-4.

1860. *Heterocrisina Abbottii* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 404, pl. 69, figs. 45-47.
1862. *Bicrisina Abbotii* G. & H., Jour. Acal. Nat. Sci. Phil., 2d ser., vol. 5, p. 174, pl. 21, fig. 65.
1864. *Bicrisina Abbottii* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.
1868. *Bicrisina Abbottii* Con., Cook's Geol. N. J., p. 723.
1905. *Bicrisina abbotii* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium small, composed of laterally compressed, more or less subtriangular bifurcating branches, .5 mm. or less in thickness. Zoœcia arranged in transverse or somewhat oblique rows upon two sides of the branches only, each row containing three or four zoœcia, the most anterior one in each row being the larger; the rows of zoœcia on the two opposite sides usually alternate in position. The apertures when perfect are circular, with an elevated rim, and are directed forwards or outwards. Surface of the zoarium between the rows of zoœcia, excavated, concave, smooth. Posterior surface of the branches reticulately marked, the longitudinal lines being the most conspicuous.

Remarks.—This species is one of the commoner forms in the Vincentown fauna. It is very closely related to *I. communis* d'Orb., from the Upper Cretaceous of France, and it is possible that the two forms should not be considered as distinct.

Formation and locality.—Vincentown limesand, Vincentown (154), near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Genus Filisparsa d'Orbigny.

Filisparsa contortilis (Lonsdale).

Plate XXII., Figs. 5–7.

1834. *Retepora* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 79.
1845. *Idmonea contortilis* Lons., Quart. Jour. Geol. Soc. Lond., vol. 1, p. 68, figs. a-d.
1862. *Idmonea contortilis* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 167.
1864. *Idmonea contortilis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.
1868. *Idmonea contortilis* Con., Cook's Geol. N. J., p. 723.

Description.—Zoarium consisting of more or less contorted, flattened, dividing and anastomosing branches from .5 mm. to 1 mm. in width, with zoœcal apertures on one side only, the reverse side being flattened or slightly convex and marked by transverse wrinkles which are curved forward in the middle, and in somewhat worn specimens marked also by longitudinal lines which indicate the lateral boundaries of the zoœcia. Zoœcia more or less irregularly arranged, the apertures sometimes in short transverse rows, and again scattered irregularly, sometimes absent from considerable areas of the surface, usually about .1 mm. in diameter; the terminal portion of the zoœcia free, cylindrical and inclined slightly forward, the procumbent portion rounded and bounded laterally by longitudinal furrows upon the surface of the zoarium.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Filisparsa bifurcata Ulrich and Bassler n. sp.

Plate XXII., Fig. 8.

Desccription.—Zoarium consisting of somewhat flattened dichotomously dividing branches from .5 mm. to 1.2 mm. in width. Zoœcial apertures occupying one side only, the reverse side being

nearly flat or slightly convex and marked by transverse wrinkles which curve convexly forward. The zoœcia more or less irregularly arranged, the apertures often showing a tendency to be arranged in transverse or diagonal rows, about .2 mm. in diameter, the terminal portion of the zoœcia free, cylindrical, inclined forward, the procumbent portion transversely rounded and bounded laterally by longitudinal furrows upon the surface of the zoarium.

Remarks.—This species resembles *F. contortiles,* but is larger with larger and fewer zoœcia, and the branches less commonly anastomosing.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Family ENTALOPHORIDAE.

Genus ENTALOPHORA Lamark.

Entalophora conradi Gabb & Horn.

Plate XXII., Fig. 9.

1862. *Entalophora Conradii* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 170, pl. 21, fig. 59.

1864. *Entalophora Conradii* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.

1868. *Entalophora Conradii* Con., Cook's Geol. N. J., p. 723.

Description.—Zoarium, consisting of small, cylindrical, sometimes bifurcating branches about .38 mm. in diameter. Zoœcia arranged in about 10 vertical rows, the apertures placed alternately in adjacent rows so as to give them also a spiral arrangement; the apertures subovate in outline, broadest and somewhat truncate above, the upper margin slightly elevated as a projecting lip, the spaces between the apertures in the vertical rows slightly concave, about equaling the apertures themselves in length.

Remarks.—The type of this species seems to have been lost or destroyed, as it is not mentioned in Johnson's list of types in the collection of the Philadelphia Academy of Sciences, and the speci-

mens which have been so identified do not entirely agree with Gabb & Horn's original illustration. There seem to be no other specimens in the New Jersey collections, however, which can be referred to this species, and it is entirely possible that the differences between our specimens and the one used for illustration by Gabb & Horn is due to their more worn condition.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Genus Spiropora Lamark.

Spiropora calamus Gabb & Horn.

Plate XXII., Fig. 10.

1862. *Spiropora calamus* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 166, pl. 21, fig. 55.
1864. *Spiropora calamus* Meek, Check List Inv. Foss N. A., Cret. and Jur., p. 4.
1868. *Spiropora calamus* Con., Cook's Geol. N. J., p. 723.

Description.—Zoarium small, consisting of cylindrical branches. Zoœcia in annular rows of about eight each, the apertures circular, their diameter about one-fourth the distance between the successive annular rows, in the area between the apertures the zoœcia are bounded laterally by prominent, longitudinal ribs.

Remarks.—This species has not been met with in the recent collections. It was established upon a single specimen which seems to have been lost or destroyed, but if the original description and illustration are accurate the species is so distinct from any of its associates that there should be no difficulty in recognizing it should it be met with in the future.

Formation and locality.—Vincentown limesand, Timber Creek (Gabb and Horn).

Geographic distribution.—New Jersey.

Genus CLAUSA d'Orbigny.

Clausa americana Gabb & Horn.

Plate XXII., Fig, 11.

1862. *Fascipora Americana* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 165, pl. 21, fig. 54.
1864. *Fasciopora americana* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.
1868. *Fasciopora Americana* Con., Cook's Geol. N. J., p. 723.
1905. *Fascipora americana* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium irregularly branched or bifurcating, usually composed of robust, clavate branches from .5 mm. to 1.5 mm. in diameter, sometimes more slender and tortuous. Younger zoœcia crowded at the extremities of the branches, mature zoœcia arranged irregularly upon the sides of the branches, or in more or less distant longitudinal rows, the apertures sub-circular, about .1 mm. in diameter, the distance between the apertures from one to four times their diameter, the terminal portion of the zoœcia slightly exsert.

Remarks.—The broken branches of this species bear some superficial resemblance to the branches of *Diastopora lineata,* but the branches of *Diastopora* are always tubular, while those of *Clausa* are solid.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Family FASCIGERIDAE.

Genus FILIFASCIGERA d'Orbigny.

Filifascigera megaera (Lonsdale).

Plate XXII., Figs. 12–15.

1845. *Tubulipora Megaera* Lons., Quart. Jour. Geol. Soc. Lond., vol. 1, p. 69, figs. a-b.
1862. *Filifascigera megaera* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 165, pl. 21, fig. 53.

1864. *Filifascigera megaera* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.
1868. *Filifascigera megæra* Con., Cook's Geol. N. J., p. 723.
1896. *Filifascigera megaera* Ulrich, Zittel-Eastman, Text Book of Pal., vol. 1, p. 263, fig. 421.

Description.—Zoarium encrusting, consisting of minute, flattened, bifurcating and anastomosing branches from .3 mm. to .4 mm. wide in their broadest parts opposite the bases of zoœcal groups, the lateral margins converging posteriorly to about one-half that width just in front of the next preceding group of zoœcia, the dorsal surface transversely convex. Zoœcia fasciculate in groups of from two to five, situated at the summit of tubular processes which rise at nearly right angles from the center of the broadest portions of the zoarium; in rare instances the erect zoœcal processes bifurcate above.

Remarks.—In its habit of growth this species resembles *Stomatopora regularis,* but it can always be easily distinguished from that species by reason of its fasciculate zoœcia.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek (Gabb and Horn).

Geographic distribution.—New Jersey.

Family LICHENOPORIDAE.

Genus DISCOCYTIS d'Orbigny.

Discocytis eccentrica Ulrich and Bassler n. sp.

Plate XXII., Figs. 16–19.

Description.—Zoarium more or less irregularly cup-shaped, supported by a very short pedicle with a slightly expanded base, above which the outer surface expands rapidly to its maximum width, which varies from 3 mm. to 7 mm.; the upper surface of the zoarium marked by strong radiating ridges or lamellae, which usually bifurcate once or twice or branch somewhat irregularly. Zoœcia small, subcircular in cross-section, the apertures occupying the entire outer surface of the zoarium and the outer extremities of the lamellæ of the upper surface; the depressions

between the lamellæ and also their upper margins when perfect, are non-celluliferous and are marked by radiating striæ.

Remarks.—This little species is rather common at Vincentown, and the more regular examples frequently have a strong superficial resemblance to a minute cup coral. The species somewhat resembles the European *D. eudesii* (Mich.), from the Upper Cretaceous of France, but is a smaller form, and judging from d'Orbigny's illustration, is much more irregular in its habit of growth.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Genus LICHENOPORA Defrance.

Lichenopora papyracea (d'Orbigny).

Plate XXII., Fig. 20.

1852. *Unitubigera papyracea* d'Orb., Pal Franc., Terr. Cret., Tom. 5, p. 761, pl. 643, figs. 12-14.

Description.—Zoarium forming small, encrusting, subcircular colonies, the maximum diameter of one colony being 4 mm. Zoœcia subcircular in outline or sometimes subpolygonal, about .1 mm. in diameter, those towards the center of the zoarium more or less covered with an epitheca indicating that the living portion of the zoarium was around its outer border.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Family CERIOPORIDAE.

Genus HETEROPORA Blainville.

Heteropora parvicella (Gabb & Horn).

Plate XXIII., Figs. 1–2.

1860. *Multicrescis parvicella* G. & H., Proc. Acad. Nat. Sci. Phil., 1860, p. 367.

1860. *Multicresis parvicella* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 401, pl. 69, figs. 36-38.

1862. *Multicrescis parvicella* G. & H., Jour. Acad. Nat. Sci. Phil,, 2nd ser., vol. 5, p. 178, pl. 21, fig. 70.
1864. *Multicresis parvicella* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.
1868. *Multicrescis parvicella* Con., Cook's Geol. N. J., p. 723.
1905. *Multicresis parvicella* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium consisting of small subcylindrical branches without an axial tube, usually a little over 1 mm. in diameter, and more or less irregularly dividing and coalescing. Zoœcia circular, irregularly arranged, remote, surrounded by a raised rim when perfect. The spaces between the zoœcia occupied by numerous, irregularly arranged smaller mesopores whose apertures are situated in the bottoms of rounded or angular depressions.

Remarks.—This species superficially resembles *Cavaria dumosa* Ulrich, from the Eocene of Maryland, but the branches of the New Jersey species are more slender and divide less frequently, and the zoœcia and mesopores are somewhat more scattered. The most important difference, however, is in the absence of the central axial hollow or tube in the New Jersey form, the character which distinguishes the genus *Heteropora* from *Cavaria*. In worn specimens of this species the zoœcia and mesopores are more nearly equal in size, and the appearance of the specimens is much changed.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Family MELICERITITIDAE.

Genus RETELEA d'Orbigny.

Retelea ovalis Gabb & Horn.

Plate XXIII., Figs. 3–4.

1862. *Retelea ovalis* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 164, pl. 21, fig. 52.
1864. *Retelea ovalis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.

1868. *Retelea ovalis* Con., Cook's Geol. N. J., p. 723.
1905. *Retelea ovalis* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—Zoarium consisting of irregularly anastomosing, vertical, bifoliate lamellae about .25 mm. in thickness, the openings between the lamellae being exceedingly irregular with widths varying from 1 mm. to 4 mm. The entire zoarium forms masses 5 mm. to 10 mm. in thickness, sometimes of considerable lateral extent. Zoœcia occupying both sides of the vertical lamellae and somewhat regularly arranged in vertical and diagonal lines. The apertures oval or elliptical, somewhat variable in form, closed in the old zoœcia by a flat, smooth operculum which is separated from the rim of the aperture by a slightly depressed ring. The spaces between the apertures usually regularly depressed.

Remarks.—This species can always be easily recognized from the habit of growth of the zoarium, it being different in this respect from any of its associates.

Formation and locality.—Vincentown limesand, Vincentown (154), near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Order CHILOSTOMATA.

Family ONYCHOCELLIDAE.

Genus FLUSTRELLA d'Orbigny.

Flustrella ? capistrata Gabb and Horn.

Plate XXIII., Figs. 5-6.

1862. *Flustrella capistrata* G. & H. Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 161, pl. 20, fig. 48.
1862. *Membranipora abortiva* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 157, pl. 20, fig. 41.
1864. *Membranipora abortiva* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1864. *Flustrella capistrata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.

1868. *Flustrella capistrata* Con., Cook's Geol. N. J., p. 723.
1905. *Membranipora abortive* Johns., Proc. Acad. Nat. Sci. Phil. 1905, p. 5.

Description. Zoarium consisting of cylindrical branches about .5 mm. in diameter, which sometimes bifurcate, and which rise from a more or less irregular incrusting base. Zoœcia arranged in from six to eight vertical columns upon the cylindrical branches, usually opposite in adjacent rows so as to form annular rows also; upon the expanded base the zoœcia are irregularly arranged. Each zoœcium about .25 mm. in length, usually divided into two portions, the aperture below, elliptical in outline, surrounded by a raised border, about .15 mm. in length at the summit of the border; above the aperture is a smaller, depressed, quadrangular or sub-crescentic area also surrounded by a raised border, in some zoœcia, perhaps in all when they are perfect, this region is covered by a domeshaped wall to form an ovicell. Avicularia small, equaling the zoœcia in number, and placed in the angles between them, surrounded by a raised border. Upon the expanded basal portion of the zoarium the zoœcia are irregularly arranged, with the apertures more oval in outline, with the avicularia less numerous and irregularly arranged.

Remarks.—The basal expansions of this species were originally described as a distinct species under the name *Membranipora abortiva* G. & H., but the two supposed forms are evidently but different parts of the colonies of a single species.

Formation and locality.—Vincentown limesand, Vincentown (154). Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Genus Onychocella Jullien.

Onychocella digitata (Morton).

Plate XXIII., Figs. 7–10.

1834. *Eschara digitata* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 79, pl. 13, fig. 8.
1845. *Eschara digitata* Lons., Quart. Jour. Geol. Soc. Lond., vol. 1, p. 73, figs. c, d, g, (?a, b), (not e, f).

1862. *Eschara digitata* G. &. H., Jour, Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 114.
1864. *Eschara digitata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1868. *Pliophlae sagena* Cook, Geol. N. J., p. 376, fig.
1868. *Eschara digitata* Con., Cook's Geol. N. J., p. 722.
1901. *Eschara (??) digitata* Ulrich, Md. Geol. Surv., Eocene, p. 216, pl. 60, figs. 10-11.

Description.—"Zoarium bifoliate, branching dichotomously; branches flattened, acutely elliptical in cross-section, usually 2.5 to 3.0 mm. wide. Zoœcia hexagonal, regularly arranged in quincunx, about 0.55 mm. long and 0.38 wide, bounded by a slightly impressed line; surface concave, especially toward the aperture which is situated usually just in front of the center. Aperture semielliptical, rounded in front, straight behind, 0.10 to 0.12 mm. wide. Normally developed and perfect, the posterior border of the aperture is slightly raised and bears a delicate lunarium-like curved plate which extends into the aperture. Abortive cells, possibly of the nature of vicarious avicularia, are frequent, but seem to be entirely restricted to the edges of the zoarium and to those portions lying just beneath the axes of bifurcation. They are distinguished from the other cells by their subcircular and usually much smaller apertures. Oœcia unknown." (Ulrich).

Remarks.—This is by far the most abundant species of bryozoan in the Vincentown beds of New Jersey. At times its broken zoaria constitute a large percentage of considerable beds, the species occurring almost to the exclusion of all others. All other species of bryozoans in this fauna are rare as compared with this one.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Genus Biflustra d'Orbigny.

Bifulstra torta Gabb & Horn.

Plate XXIII., Figs. 11–12.

1862. *Biflustra torta* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 152, pl. 20, fig. 36.

1864. *Biflustra torta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.

1868. *Biflustra torta* Con., Cook's Geol. N. J., p. 722.

1901. *Biflustra torta* Ulrich, Md. Geol. Surv., Eocene, p. 214, pl. 60, fig. 7.

1905. *Biflustra torta* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium consisting of bifoliate, compressed, more or less twisted, bifurcating branches, which rarely continue in the same plane for more than 5 mm., with from 6 to 10 rows of zoœcia on each side, except below the points of bifurcation, where there may be a larger number of rows. Zoœcia arranged in longitudinal lines, and usually in quincunx, usually about .3 mm. in length. Zoœcial apertures usually about one-half the length of the zoœcium, subelliptical in outline, placed anteriorily, the margins elevated anteriorly and laterally; the posterior surface of the zoœcia sloping downward from the elevated border of the one next behind to the posterior margin of the aperture. Ovicells usually absent, and only rarely present in any considerable numbers; they are cucullate, semi-globular in form, with the opening directed posteriorly; the posterior margin of the dome-like covering extends backward to the anterior margin of the zoœcial aperture just behind. Avicularia scattered irregularly among the other zoœcia, of which they are but modified individuals about two-thirds of the usual size.

Remarks.—Besides its occurrence in the Cretaceous beds of New Jersey, this species has been recognized also in the Eocene of Maryland. It is rather common form, and was apparently mistaken by Lonsdale, and illustrated by him as an immature form of *Onychocella digitata* (Mort.). These two forms, however, are distinctly different.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey; also Eocene of Maryland.

Biflustra disjuncta Gabb & Horn.

Plate XXIII., Fig. 13.

1862. *Biflustra disjuncta* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 153, pl. 20, fig. 37.

1864. *Biflustra disjuncta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.

1868. *Biflustra disjuncta* Con., Cook's Geol. N. J., p. 722.

Description.—Zoarium bifoliate, compressed. Zoœcia robust, elongate-hexagonal in outline, growing in longitudinal series and arranged in quincunx; the zoœcia in each longitudinal series are firmly united end to end, but the adhesion along the lateral margins and at the back is very slight. Zoœcial apertures terminal, oval, somewhat variable in form; the floor of the zoœcium sloping upward in front and merging into the surface of the zoarium in such a manner as to nearly or quite obliterate the anterior margin of the aperture. Outer surface of the zoœcia smooth, rounding slightly inward to the aperture and to the constriction between the apertures in the same longitudinal series.

Remarks.—This species is one of the rarer forms, and has not been met with in the recent collections. It was founded upon two fragments only, and even these seem to have been lost or destroyed. The characters of the species are such, however, if the original description and illustration of Gabb and Horn are accurate, that it can be easily recognized should it be met with in the future collections.

Formation and locality.—Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Family MEMBRANIPORIDAE.

Genus AMPHIBLESTRUM Gray.

Amphiblestrum heteropora (Gabb & Horn).

Plate XXIII., Figs. 14–16.

1862. *Reptoflustrella ? heteropora* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 162, pl. 20, fig. 50.

1864. *Reptoflustrella* (?) *heteropora* Meek, Check List. Inv. Foss. N. A., Cret. and Jur. p. 4.

1868. *Reptoflustrella* ? *heteropora* Con., Cooks Geol. N. J., p. 723.

1901. *Reptoflustrella heteropora* Ulrich, Md. Geol. Surv., Eocene, p. 213, pl. 60, figs. 8-9.

1905. *Reptoflustrella heteropora* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium encrusting in irregular patches, usually growing upon other species of bryozoa. Zoœcia in a single layer, usually arranged with but little regularity, but sometimes exhibiting a tendency to grow in radiating lines, longer than wide, pointed in front, broadly subtruncate behind; aperture about .15 mm. in width, subtriangular in outline with convex sides, often approaching an oval form in very long zoœcia; bordered anteriorly and laterally by a slightly elevated, rounded ridge which becomes obsolete posteriorly. Just in front of the anterior angle of the zoœcal aperture is a small subcircular pore, probably the point of attachment of an avicularium. Posterior portion of the zoœcia covered with a regularly convex, smooth wall, which in old zoaria is continued over the entire surface, totally obliterating the aperture.

Remarks.—This species has been identified by Ulrich from the Eocene beds of Maryland, but these Eocene examples are coarser in appearance and the front wall of the apertural margin is distinctly granular. It is altogether possible that the Eocene examples should be considered as a distinct species.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey, also Eocene of Maryland.

Genus MEMBRANIPORA Blainville.

Membranipora plebia Gabb & Horn.

Plate XXIII., Fig. 17.

1862. *Membranipora plebia* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 158, pl. 20, fig. 43.

1864. *Membranipora plebia* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1868. *Membranipora plebeia* Con., Cook's Geol. N. J., p. 723.
1896. *Membranipora plebeia* Ulrich, Zittel-Eastman Text Book of Pal., p. 287, fig. 478.

Description.—Zoarium encrusting, growing upon shells, echinoids and other bryozoans. Zoœcia in a single layer, from .3 mm. to .4 mm. in length, their width about two-thirds the length, usually with a quincunxial arrangement, the adjacent ones separated by a distinct depressed line which sometimes widens so as to form small open spaces. Zoœcal apertures elliptical or ovate in outline, large, leaving a very narrow zoœcial wall. Ovicells variable in their distribution, sometimes abundant, but usually much scattered. Avicularia few in number.

Formation and locality.—Vincentown limesand, Vincentown (154), near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Membranipora annuloidea Ulrich and Bassler n. sp.

Plate XXIII., Fig. 18.

Description.—Zoarium encrusting. Zoœcia from .5 mm., to .65 mm. in length, their width about three-fourths their length, more or less hexagonal in outline, sharply defined by depressed furrows. Zoœcial apertures about .2 mm. in length, subovate in outline, surrounded by a rather broad, somewhat elevated, rounded marginal rim which is marked by a series of from 10 to 13 small subcircular pits with raised borders. Ovicells variable in their distribution, either abundant or much scattered, usually a little broader than long with the side next the zoœcial aperture somewhat flattened, about .15 mm. in width.

Remarks.—This species is rather rare at Vincentown. When worn, the marginal ring of pits about the zoœcial apertures are more or less obscure and sometimes wanting entirely. The species somewhat resembles the Italian Tertiary species *M. annulus* Manzoni,[1] but differs in having more rounded zoœcia and more numerous pores.

[1] Bryoz. Foss. Ital., 4th Contrib., p. 7, Tav. 1, fig. 6.

Formation and locality.—Vincentown limesand, Vincentown, (154).

Geographic distribution.—New Jersey.

Membranipora nematoporoides Ulrich and Bassler n. sp.

Plate XXIV., Figs. 1–2.

Description.—Zoarium consisting of narrow subquadrangular or subcylindrical branches .6 to .7 mm. in diameter which are celluliferous on all sides, the zoœcia being arranged in from four to six vertical rows. Zoœcia about twice as long as wide, their length about .33 mm., surrounded by a rather sharp, slightly elevated rim which is surmounted by a series of sharp tubercles or minute spines. Avicularia rather numerous, very large and beak-like.

Remarks.—In its method of growth and general aspect this species resembles members of Ulrich's genus *Nematopora*. The species is not uncommon at Vincentown, and may be easily recognized by the spines surrounding the zoœcial apertures and by the large beak-like avicularia.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Membranipora jerseyensis Ulrich and Bassler n. sp.

Plate XXIV., Fig. 3.

Description.—Zoarium bifoliate, zoœcia from .6 to .85 mm. in length and from .45 to .50 mm. wide, arranged more or less regularly in quincunx. Zoœcial apertures subelliptical in outline, .4 to .5 mm. in length, their width from one-half to three-fourths the length. The spaces between the zoœcial apertures rounded and occupied by numerous, rather large pores. Ovicells usually abundant.

Remarks.—This species may be recognized by the numerous pores occupying the interapertural spaces. It is not uncommon at Vincentown.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Membranipora perampla Gabb & Horn.

Plate XXIV., Fig. 4.

1862. *Membranipora perampla* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 158, pl. 20, fig. 42.
1864. *Membranipora perampla* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1868. *Membranipora perampla* Con., Cook's Geol. N. J., p. 723.
1905. *Membranipora perampla* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium encrusting, growing upon other bryozoa and upon shells. Zoœcia forming a single layer, more or less regularly hexagonal in outline, usually about .45 mm. in length with the width two-thirds the length, arranged in quincunx, not surrounded by a distinct depressed line, though at the angles the surface is usually slightly depressed. Aperture large, elliptical or sometimes nearly circular in outline, the zoœcial walls thin. Both ovicells and avicularia rare or entirely wanting.

Formation and locality.—Vincentown limesand, Vincentown (154), near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Genus Pyripora d'Orbigny.

Pyripora irregularis Gabb & Horn.

Plate XXIV., Fig. 5.

1860. *Hippothoa irregularis* G. & H., Proc. Acad. Nat. Sci. Phil., 1860, p. 366.
1860. *Hippothoa irregularis* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 400, pl. 69, figs. 18–20.
1862. *Pyripora irregularis* G. &. H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 157, pl. 20, fig. 40.
1864. *Pyripora irregularis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1868. *Pyripora irregularis* Con., Cook's Geol. N. J., p. 723.
1905. *Pyripora irregularis* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium incrusting, composed of robust zoœcia about .5 mm. in length, frequently branching, one or two branches being given off laterally or anteriorly from a single zoœcium at various angles. Zoœcia pyriform, strongly convex towards the front, with thin, unornamented walls, very narrow posteriorly, becoming rapidly wider anteriorly, in some cases becoming nearly elliptical. Apertures large, subelliptical in outline, situated anteriorly, sometimes bordered posteriorly by a slightly-elevated lip. Ovicells often present.

Remarks.—The colonies of this species have been usually observed growing upon *Onychocella digitata,* and only in rare instances are there more than 10 or 12 zoœcia in one group.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Genus PLANICELLARIA d'Orbigny.

Planicellaria oculata d'Orbigny.

Plate XXIV., Figs. 6–7.

1850. *Planicellaria oculata* d'Orbigny, Pal. Franc., Terr. Cret. Tom., 5, p. 37, pl. 653, figs. 1-5.

Description.—Zoarium consisting of cylindrical branches more or less subelliptical in cross-section, with from 8 to 10 longitudinal rows of zoœcia. Zoœcia arranged more or less regularly in quincunx, sharply separated, about 0.6 mm. in length. Zoœcial apertures small, elliptical in outline, about 0.1 mm. in length, around the aperture of each zoœcia is a rather broad, slightly convex region extending to the zoœcial margin, except above, where there is a rather large ovicell. The ovicells upon the narrower sides of the branches much larger than those upon the broader and flatter sides.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Planicellaria cylindrica Gabb & Horn.

Plate XXIV., Fig. 8.

1862. *Flustrella cylindrica* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 161, pl. 20, fig. 49.
1864. *Flustrella cylindrica* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.
1868. *Flustrella cylindrica* Con., Cook's Geol. N. J., p. 723.

Description.—Zoarium consisting of cylindrical or oval (?) branches, with six longitudinal rows of zoœcia in the type specimen, arranged in quincunx. Zoœcia divided externally into two subequal regions; the anterior region convex and oval, with its longest diameter the greater, pierced in its center by a circular or oval aperture whose diameter is about one-third the width of the zoœcium; the posterior region is flatter and supports a subquadrate labiate process, probably the point of attachment of an avicularium, which is depressed behind and elevated in front; it is truncated above so that the opening is directed forward and upward.

Remarks.—This species resembles the last, differing chiefly in the smaller number of rows of zoœcia.

Formation and locality.—Vincentown limesand, near Mullica Hill (Gabb and Horn), Vincentown (154).

Geographic distribution.—New Jersey.

Genus ESCHARINELLA d'Orbigny.

Escharinella altimuralis Ulrich and Bassler n. sp.

Plate XXIV., Figs. 9–10.

Description.—Zoarium encrusting, zoœcia subrhomboidal in outline, about 0.5 mm. in length, with very thin walls. At each angle is a rather large avicularium, subcircular or subelliptical in outline, with walls somewhat thicker than those of the zoœcia.

Remarks.—This is a very distinct species, abundant at Vincentown, which may be easily recognized by its thin walls and prominent avicularia.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Genus REPTOMULTICAVA d'Orbigny.

Reptomulticava cepularis Gabb & Horn.

1860. *Reptomulticava cepularis* G. & H., Proc. Acad. Nat. Sci. Phil., 1860, p. 367.
1860. *Reptomulticava cepularis* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 401, pl. 69, figs. 33-35.
1862. *Reptomulticava crepularis* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 177.
1864. *Reptomulticava cepularis* Meek, Check List Inv. Foss., Cret. and Jur., p. 4.
1868. *Reptomulticava cepularis* Con., Cook's Geol. N. J., p. 723.
1905. *Reptomulticava cepularis* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium encrusting in large masses, forming irregular tubercles or nodes, composed of a large number of layers of zoœcia superposed upon each other. Zoœcia angular, crowded, irregular, separated by prominent walls, sometimes with distinct depressed lines between them. The width of one zoarium, the type specimen, is over 60 mm. in one direction.

Formation and locality.—Vincentown limesand, Timber Creek (Gabb and Horn).

Geographic distribution.—New Jersey.

Family CRIBRILINIDAE.

Genus CRIBRILINA Gray.

Cribrilina sagena (Morton).

Plate XXIV., Figs. 11–12.

1834. *Flustra sagena* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 79, pl. 13, fig. 7.
1845. *Escharina ? sagena* Lons., Quart. Jour. Geol. Soc. Lond., vol. 1, p. 71, figs. a-c.

1862. *Pliophlœa sagena* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 150, pl. 20, fig. 34.
1864 *Pliophlœa sagena* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1868. *Pliophlœa sagena* Con., Cook's Geol. N. J., p. 722.
1905. *Pliophlœa sagena* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium consisting of rather broad, irregularly branching, more or less tortuous plates composed of several layers of zoœcia superimposed one upon the other. Zoœcia in close contact all around, elongate-subelliptical or subquadrangular in outline; from 0.3 mm. to 0.4 mm. in length, the width usually about one-half the length, arranged more or less regularly in longitudinal lines and in quincunx. Zoœcial apertures terminal, small, 0.1 mm. or less in diameter, subcircular or subquadrate in outline; back of the aperture the outer surface of the zoœcia is covered by a thin, nearly flat or slightly convex wall, which is marked by about 16 straight rows of fine perforations, which extend inward from and at right angles to the margin of the zoœcium. Avicularia small, subcircular or subelliptical in outline, two in number for each zoœcium, situated one on either side of the zoœcial aperture. Ovicells scattered irregularly over the surface of the zoarium, usually not abundant; they are smooth, dome-shaped bodies, considerably larger than the zoœcial apertures just above which they are always situated.

Remarks.—Next to *Onychocella digitata* this is the commonest species of bryozoan in the Vincentown fauna. It can be easily recognized by its irregularly dividing and more or less twisted, flabellate branches.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Cribrilina immersa (Gabb & Horn).

1862. *Escharipora immersa* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 149.
1864. *Escharipora immersa* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.

1868. *Escaripora immersa* Con., Cook's Geol. N. J., p. 722.
1905. *Escharipora immersa* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium consisting of large, thick, tortuous, anastomosing plates with zoœcia on both sides. Zoœcia elongate-oval with parallel sides. Zoœcial apertures occupying the entire width of the visible portion of the zoœcia, and from one-fourth to one-fifth of its length, the front margin rounded, the posterior margin straight. Surface of the zoœcia back of the aperture very distinctly depressed below the surface of the zoarium, marked by five or six pairs of transverse furrows which reach almost to the middle, leaving a narrow, median, imperforate line. Avicularia numerous, but the exact number not determined, situated in advance of and around the apertures.

Remarks.—This species was established upon a single large zoarium, 100 mm. in length by 50 mm. in width and height, which is the only specimen as yet observed.

Formation and locality.—Vincentown limesand, Timber Creek (Gabb and Horn).

Geographic distribution.—New Jersey.

Genus MEMBRANIPORELLA Smitt.

Membraniporella abbottii (Gabb & Horn).

Plate XXIV., Figs. 13–14.

1862. *Escharipora Abbottii* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 149, pl. 20, fig. 33.
1862. *Repteschariporα marginata* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 151, pl. 20, fig. 35.
1864. *Escharipora Abbottii* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1864. *Raptascharipora marginata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1868. *Escharipora Abbottii* Con., Cook's Geol. N. J., p. 722.
1868. *Reptescaripora marginata* Con., Cook's Geol. N. J., p. 722.

1896. *Membraniporella Abbotti* Ulrich, Zittel-Eastman Text Book of Pal., p. 287, fig. 479.

1905. *Escharipora abbottii* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium encrusting or growing in bifoliate plates. Zoœcia elongate-subelliptical or subhexagonal in outline, usually arranged in more or less regular longitudinal series and in quincunx, about 0.5 mm. in length, the length about twice the width. Zoœcial apertures subcircular or subquadrate with rounded angles, sometimes rounded in front and truncate posteriorly; they are situated anteriorly and occupy about one-third of the length of the zoœcium; back of the aperture the surface is covered by a thin, flat or slightly convex wall slightly depressed below the zoœcial margin, which is marked by about 14 or 15 lateral grooves radiately arranged posteriorly, leaving a narrow, smooth area along the median line, these grooves are either slit-like openings through the wall or they are pierced by lines of pores, it cannot be determined which from the specimens observed. Avicularia usually two to each zoœcium, subovate in outline and situated one on each side of the zoœcial aperture, from the lateral margins of which they are directed obliquely outward and backward. Ovicells present or absent, subglobular in form, situated just in front of the zoœcial apertures.

Remarks.—Gabb and Horn apparently gave two names to this species, *Escharipora Abbottii* to those forms in which the ovicells are wanting, and *Reptescharipora marginata* to those in which the ovicells are present. Both conditions are apparently present in one and the same species. The species resembles *Cribrilina modesta* Ulrich,[1] from the Eocene of Maryland, and if the grooves upon the outer walls of the zoœcia should be found to be furnished with lines of pores in their bottoms, and not to be open slits, the species should doubtless be referred to the genus *Cribrilina* rather than *Membraniporella.*

Formation and locality.—Vincentown limesand, Vincentown (154), near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

[1] Md. Geol. Surv., Eocene, p. 218, pl. 60, Figs. 12–13.

Membraniporella distans (Gabb and Horn).

Plate XXV., Fig. 1.

1862. *Escharipora distans* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 148, pl. 20, fig. 32.
1864. *Escharipora distans* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1868. *Escaripora distans* Con., Cook's Geol. N. J., p. 722.

Description.—Zoarium robust, apparently consisting of a tortuous, anastomosing series of plates with zoœcia on both sides. Zoœcia small, elongate, often acuminate at the proximal end, arranged in longitudinal lines and quincunx, apparently separated longitudinally sometimes to the extent of the length of a zoœcium; the longitudinal series are very close together and occasionally, though rarely, the ornamented portions of two zoœcia occur without any depression between them. Zoœcial apertures small, round, oval or subquadrate, usually bordered by a thickened raised lip which is usually continued around the avicularia and disappears towards the proximal end. Outer wall of the posterior portion of the zoœcia not differentiated from the general surface of the zoarium, but just back of the aperture there is an elongate, subelliptical, differentiated area which is pierced by 10 or 12 slit-like pores directed at right angles to the margin of the elliptical area, leaving a central imperforate space. Avicularia small, subovate or subelliptical, situated one on either side of each zoœcial aperture, from the margin of which they are directed obliquely outward and backward. Ovicells large, elongate, rounded anteriorly and generally constricted near the zoœcial aperture, marked above by an impressed circle or ellipse which circumscribes a hemispherical portion covering the larger part of its surface.

Remarks.—This species is imperfectly known as it has not been met with in the recent collections and the original specimen seems to have been lost or destroyed. It seems to be characterised, however, by the apparent separation of the zoœcia in the longitudinal series upon the surface of the zoarium, and also by the large hemispherical ovicells.

Formation and locality.—Vincentown limesand, Timber Creek (Gabb and Horn).

Geographic distribution.—New Jersey.

Family MICROPORIDAE.

Genus REPTOPORINA d'Orbigny.

Reptoporina carinata Gabb and Horn.

1860.. *Cellepora carinata* G. & H., Proc. Acad. Nat. Sci. Phil., 1860, p. 366.
1860. *Cellepora carinata* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 400, pl. 69, figs. 24-26.
1862. *Reptoporina carinata* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 144.
1864. *Reptoporina carinata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1868. *Reptoporina carinata* Con., Cook's Geol. N. J., p. 722.
1905. *Cellepora carinata* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium encrusting. Zoœcia sharply defined, elongate-hexagonal, the sides straight, the proximal end narrowest, arranged in regular quincunx. Zoœcal apertures anterior in position and directed obliquely forward, ovate to subquadrate in outline, proximal margin straight or concave (sometimes with a median tooth projecting forward?). Outer surface of the zoœcia carinate along the median line or rarely rounded, the carina reaching its highest point a little back of the aperture, from which point the surface slopes downward in front to the proximal margin of the aperture. Upon the sloping surface between the highest point of the outer zoœcal wall and the proximal margin of the aperture, is a small pore which doubtless indicates the position of an avicularium.

Remarks.—This species may be distinguished from any of its associates by the elongate-hexagonal, usually carinate zoœcia, with the avicularia situated just back of the proximal margin of the aperture.

Formation and locality.—Vincentown limesand, Timber Creek (Gabb and Horn).

Geographic distribution.—New Jersey.

Genus REPTESCHARELLINA d'Orbigny.

Reptescharellina prolifera Gabb & Horn.

Plate XXV., Fig. 2.

1862. *Reptescharellina prolifera* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 146, pl. 20, fig. 28.
1864. *Escharellina prolifera* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1905. *Reptescharellina prolifera* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium incrusting. Zoœcia arranged in quincunx and in radiating lines from a central group of two or three zoœcia which are somewhat smaller than the rest although perfectly developed in all their structural details; form of the zoœcia oval, elongated, convex, slightly more elevated at the distal than at the proximal end, separated from each other laterally by distinct depressed lines produced by the meeting of the convex surfaces, and anteriorly by the elevation of the distal extremity above the proximal extremity of the succeeding zoœcium.

Zoœcial apertures rounded-subquadrate to circular in outline, bordered by an abrupt but little thickened lip which also encircles the avicularia. Avicularia rather large, generally elongated longitudinally, often narrowed at their anterior extremity, situated one about midway upon either side of each zoœcial aperture. Ovicels numerous, small, subglobular, rounded anteriorly and emarginate at the border of the zoœcial aperture.

Remarks.—This is a rare form which has not been met with in the recent collections, but its characters seem to be sufficiently distinct to admit of its easy recognition in case it is met with in future collections.

Formation and locality.—Vincentown limesand, near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Genus Micropora Gray.

Micropora cylindracea Ulrich and Bassler n. sp.

Plate XXV., Fig. 4.

Description.—Zoarium consisting of cylindrical stems about 0.5 mm. in diameter, celluliferous on all sides with about nine longitudinal rows of zoœcia. Zoœcia elongate, subelliptical in outline, slightly truncated posteriorly by the rounded end of the one next behind, about 0.5 mm. in length with the width a little less than one-half the length, surrounded by a slightly raised, narrow, convex border. Zoœcial apertures anterior, small, subsemicircular in outline, nearly twice as wide as long. Back of the aperture the surface of the zoœcia is covered by a thin, flat wall, slightly depressed below the raised zoœcial margin, through which a little in front of the mid length of the zoœcium, there is a pair of small, longitudinal, slit-like pores, one on each side close up to the raised border. Avicularia frequently present, situated in the lower, right-hand corner of the zoœcia.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Micropora pulchra Ulrich and Bassler n. sp.

Plate XXV., Fig. 3.

Description.—Zoarium consisting of cylindrical branches, 0.5 mm. to 1 mm. in diameter, which divide dichotomously, with zoœcial openings on all sides, the openings arranged in from 6 to 9 longitudinal rows. Zoœcia rather narrowly elongate, 0.6 mm. to 0.7 mm. in length, with the width less than one-half the length, rounded anteriorly and truncated posteriorly by the rounded extremity of the zoœcium just behind, surrounded by a low, narrow, ridge-like border. Zoœcial apertures anterior, rather small, transversely subelliptical in outline, their length about two-thirds their width; back of the aperture the surface of the zoœcia is covered with a thin, slightly convex wall, without perforations, a little depressed below the marginal border. Just in

front of the aperture of each zoœcium is a small, subcircular avicularium.

Remarks.—This species may be easily distinguished from the last by its somewhat larger size, by the different shape of the zoœcial apertures, and by the absence of pores in the external zoœcial walls.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Micropora ? vincentownensis Ulrich and Bassler n. sp.

Plate XXV., Fig. 9.

Description.—Zoarium encrusting. Zoœcia about 0.5 mm. in length, the width usually a little less than the length, more or less regularly hexagonal in outline, with the anterior and posterior sides shorter than the others. Zoœcia bounded by shallow furrows, in the bottom of each of which is a very narrow, slightly-elevated ridge. Zoœcial apertures anterior in position small, subcircular or transversely subelliptical in outline, the posterior margin usually truncated, bordered by a rather thick, moderately-elevated rim. Surface of the zoœcia, back of the apertures, covered with a thin, gently convex wall without perforations of any sort.

Remarks.—This species may be recognized by its encrusting habit of growth, by the short and broad, hexagonal zoœcia and by the absence of perforations in the external zoœcial wall.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Family MICROPORELLIDAE.

Genus MICROPORELLA Hincks.

Microporella sparsipora Ulrich and Bassler n. sp.

Plate XXV., Fig. 8.

Description.—Zoarium encrusting. Zoœcia more or less subelliptical in outline, separated by rather distinctly depressed furrows, arranged in a more or less irregular manner, from 0.4 to 0.5

mm. in length. Zoœcial apertures situated anteriorly, small, transversely subelliptical in outline or semicircular by reason of the straightening of the posterior margin, bordered by a rather broad, slightly-raised rim. Surface of the zoœcia, back of the aperture, moderately convex. Avicularia rather abundant, large and conspicuous, frequently more or less elongate.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Genus Monoporella Hincks.

Monoporella exserta (Gabb and Horn).

Plate XXV., Figs. 5–7.

1862. *Cellepora exserta* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 125, pl. 19, fig. 6.
1864. *Cellepora exserta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1868. *Cellepora exserta* Con., Cook's Geol. N. J., p. 722.
1905. *Cellepora exserta* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium usually small and radiating, encrusting shells and other bryozoa. Zoœcia arranged irregularly, subovate in outline, very prominent, presenting the appearance of being attached by only a portion of the base, somewhat barrel-shaped, contracted towards the base and also towards the aperture, aperture terminal, large, round or transversely elliptical, directed upwards and forwards with a slight thickening or lip about the margin.

Remarks.—The zoaria of this species are usually small, containing from 30 to 40 zoœcia, but larger ones occasionally occur with one hundred or more zoœcia. The species can be recognized by the exsert, irregularly placed zoœcia, which give the zoaria, even to the naked eye, an unusually rough appearance.

Formation and locality.—Vincentown limesand, near Mullica Hill (Gabb and Horn), Vincentown (154).

Geographic distribution.—New Jersey.

Family PORINIDAE.

Genus PORINA d'Orbigny.

Porina labiata (Gabb & Horn).

Plate XXVI., Figs. 1–6.

1862. *Crescis labiata* G. &. H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 177, pl. 21, fig. 69
1864. *Crescis labiata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.
1868. *Crescis labiata* Con., Cook's Geol. N. J., p. 723.
1905. *Crescis labiata* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium consisting of flattened branches, which divide irregularly, varying from 0.6 mm. to 2 mm. in width, the thickness being about one-half or a little more than one-half the width, and the cross section subelliptical. Zoœcia occupying both sides of the branches, scattered or arranged more or less regularly in rows; the apertures circular, usually bordered by a slightly raised, rather broad rim; mesopores very small, scattered between the zoœcia. Certain of the zoœcia are modified to form ovicells by the inflation of the surface of the zoarium at one side, giving to the aperture an oblique direction; these ovicells are scattered irregularly over the surface, sometimes being nearly absent, while in other specimens nearly every zoœcium has been so modified.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Porina quadrangularis (Gabb & Horn).

Plate XXVI., Figs. 7–8.

1862. *Entalophora quadrangularis* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 170, pl. 21, fig. 58.
1864. *Entalophora quadrangularis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.
1868. *Entalophora quadrangularis* Con., Cook's Geol. N. J., p. 723.

Description.—Zoarium consisting of quadrangular branches, which are rounded at the angles. Zoœcia arranged on the four faces, the apertures alternating in position, the proximal margin of the aperture produced into a prominent lip, which is pointed and projects forward in the center, emarginate on the sides, the distal margin of the aperture merging into the surface of the zoarium.

Remarks.—No specimens agreeing with the original figure and description of this species have been met with in the recent collections. Certain specimens do occur, however, which have a large number of accessory pores, absent in Gabb and Horn's figure, which are believed to belong here. The type is apparently lost, but it was probably a specimen in which these pores were wanting.

Formation and locality.—Vincentown limesand, Timber Creek (Gabb and Horn).

Geographic distribution.—New Jersey.

Porina coronata (Reuss)?

Plate XXVI., Fig. 11.

1869. *Acropora coronata* Reuss, Pal. Stud., p. 277.

Description.—Zoarium consisting of flattened branches from 1 mm. to 4 mm. in width, and 1 mm. or less in thickness. Zoœcia not sharply differentiated externally; arranged more or less irregularly over the entire surface, sometimes in quite regular longitudinal lines, zoœcial apertures circular, about 0.16 mm. in diameter, the interspaces covered with numerous, more or less irregularly scattered accessory pores.

Remarks.—This species seems to be identical with the European form, but until authentic specimens can be actually compared, the identification may be made with a query.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Family ESCHARIDAE.

Genus LEPRALIA Johnston.

Lepralia aspera (Gabb & Horn).

Plate XXVI., Fig. 9.

1862. *Reptocelleporaria aspera* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 131, pl. 19, fig. 14.
1864. *Reptocelleporia aspera* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1868. *Reptocelleporia aspera* Con., Cook's Geol. N. J., p. 722.
1905. *Reptocelleporaria aspera* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium encrusting, composed of numerous superimposed layers, sometimes presenting a knotted or coarsely tuberculous surface. Zoœcia oval to rounded hexagonal in form, placed irregularly but with a tendency to a general arrangement in one direction in the same region, convex and very prominent on the surface, separated by deep irregular depressions. Zoœcal apertures anterior but not terminal, broader than long, semicircular to rounded subquadrate in outline, usually with the proximal margin straight, outer surface marked by a small number of large, rounded elevations placed irregularly, and with those nearest the edge elongated with grooves between them which resemble the slit-like openings of *Membraniporella,* these grooves are present around the entire margin of the zoœcia, and at their outer extremity a small pore is usually seen piercing the outer wall.

Formation and locality.—Vincentown limesand, Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Genus MUCRONELLA Hincks.

Mucronella muralis (Gabb & Horn).

Plate XXVI., Fig. 10.

1862. *Escharinella muralis* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 140, pl. 19, fig. 23.

1864. *Escharinella muralis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1868. *Escharinella muralis* Con., Cook's Geol. N. J., p. 722.
1905. *Escharinella muralis* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium composed of flattened, rather narrow, irregularly dividing branches, with from four to eight rows of zoœcia upon each side. Zoœcia subrhomboidal, their outer surface smooth, slightly convex, more depressed at the proximal than at the distal end, the adjacent ones often separated by a very slight raised line in the bottom of the depression formed by the meeting of the convex surfaces. Zoœcial apertures small, terminal, sometimes rounded anteriorly with the proximal margin straight, sometimes subquadrate, often with a small tooth-like projection directed forward from the proximal margin. Avicularia small, circular, equal in number to the zoœcia, situated just in advance of and close to the zoœcial apertures.

Formation and locality.—Vincentown limesand, Vincentown (154), near Mullica Hill (Gabb and Horn).

Geographic distribution.—New Jersey.

Mucronella typica (Gabb & Horn).

Plate XXVI., Figs. 12–13.

1860. *Cellepora typica* G. & H., Proc. Acad. Nat. Sci. Phil., 1860, p. 366.
1860. *Cellepora typica* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 400, pl. 69, figs. 27-29.
1862. *Escharifora typica* G. & H., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 5, p. 134, pl. 19, fig. 16.
1864. *Escharifora typica* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1868. *Escharipora typica* Con., Cook's Geol. N. J., p. 722.
1905. *Escharifora typica* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium incrusting in its early stages of growth, later rising in free, flattened, bifoliate branches, which divide more or less irregularly, usually in one plane, but sometimes

more or less tortuous. Zoœcia as seen on the growing margin of the zoarium, broadly suboval in form, but in the mature portion becoming more or less rhomboidal with the outer wall slightly concave, and in very old zoaria their borders not differentiated; they are arranged more or less irregularly or in quincunx, and have a length of about 0.3 mm. Zoœcial apertures rounded anteriorly, the proximal margin straight, and when perfect with a small tooth-like process extending forward from the median line, usually about 0.125 mm. in width. Avicularia from three to five, about each zoœcium, one, usually a little larger than the others, situated just in advance of the zoœcial aperture, two others, one on either side, nearly opposite the posterior margin of the aperture, and frequently a second pair on opposite sides of the posterior portion of the zoœcium; these avicularia are subcircular, and are usually bordered by an elevated rim-like border. Ovicells rare or absent altogether.

Formation and locality.—Vincentown limesand, Vincentown (154), Timber Creek and near Mullica Hill (Gabb and Horn).

Geographic distribution—New Jersey.

Mucronella aspera Ulrich.

Plate XXVI., Figs. 14–15.

1901. *Mucronella aspera* Ulrich, Md. Geol. Surv., Eocene, p. 221, pl. 60, figs. 17–18.

Description.—"Zoarium incrusting, consisting of one or more layers; surface, under a low power of magnification, presenting a decidedly rough aspect. Zoœcia varying from ovate-hexagonal, to sub-rhomboidal, indistinct externally, arranged more or less irregularly, though the rows are more regular than they appear at first sight; about six in 2 mm. Apertures rounded or subquadrate, 0.13 mm. in diameter, rendered oblique by the elevation of the more or less strongly swollen posterior margin and the depression of the anterior part. The central portion of the raised lip forms a "mucro" of greater or less thickness and prominence, the same hiding a minute central tooth beneath it, and forming with the rest of the thickened portion of the lip,

a more or less obscure resemblance to the figure W. Behind the lip the surface slopes rapidly, and in the most nearly perfect example is granulose. In the depressed space in front of the aperture there are, normally, three small raised avicularia (? vibracula), while a few larger avicularia, differing further from the others in being divided into two unequal parts by a cross-bar, are scattered without order among the zoœcia. Oœcia are not often seen. When present they occupy the depressed space in front of the aperture, are cucullate, about as large as the zoœcial aperture and usually bear a furrow running from the summit to the concave edge." (Ulrich.)

Remarks.—This species approaches nearer to *M. typica* than to any other, but the zoarium in the two forms is very different, this one being incrusting, while the other rises in erect bifoliate branches. The surface characters of the zoœcia are also sufficiently distinct to make the two species easily distinguishable. Besides its occurrence in the Cretaceous Vincentown beds of New Jersey, the species also occurs, and, indeed, was originally described from the Eocene of Maryland.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey; Eocene of Maryland.

Mucronella pumila (Gabb & Horn).

Plate XXVI., Fig. 16–17.

1862. *Cellepora pumila* G. & H., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 5, p. 126, pl. 19, fig. 8.
1864. *Cellepora pumila* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 3.
1868. *Cellepora pumila* Con., Cook's Geol. N. J., p. 722.
1905. *Cellepora pumila* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 5.

Description.—Zoarium encrusting. Zoœcia minute, arranged in regular lines longitudinally, but rarely in regular quincunx, subovate in outline, convex, bounded by depressed lines formed by the meeting of the convex surfaces. Zoœcial apertures very

small, anterior but not always terminal in position, subquadrate in form, without any lip or thickened border. Ovicells not infrequent, flattened, rounded, sometimes a little wider than the zoœcia to which they are attached.

Formation and locality.—Vincentown limesand, Timber Creek (Gabb and Horn); Vincentown (154).

Geographic distribution.—New Jersey.

Class BRACHIOPODA.

Order ATREMATA.

Family LINGULIDAE.

Genus LINGULA Bruguière.

Lingula subspatulata Hall and Meek.

Plate XXVII., Figs. 20–21.

1856. *Lingula subspatulata* H. & M., Mem. Am. Acad. Arts and Sci., n. ser., vol. 5, p. 380, pl. 1, figs. 2a-b.

1864. *Lingula subspatulata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 4.

1875. *Lingula subspatula* White, Rep. Geog. and Geol. Surv. w. 100th Merid., vol. 4, p. 169, pl. 15, fig. 4.

1889. *Lingula subspatulata* (?) Whiteaves, Cont. Can. Pal., vol. 1, p. 185.

Description.—Shell subelliptical in outline, pointed posteriorly and more or less subtruncate anteriorly, the lateral margins subparallel, the antero-lateral angles rounded. Surface marked by fine, concentric lines of growth, some of which are more conspicuous than others. The dimensions of one of the largest individuals observed are: length 19 mm., width 10 mm.

Remarks.—This species has been observed only in the fauna of the Woodbury clay, in which formation at Lorillard it is rather common. Among some thirty or more individuals observed, considerable variation in outline may be seen. One specimen is much more slender, more pointed posteriorly and more rounded anteriorly, having much the form of *L. nitida* M. & H., from

the Fox Hills formation of the Northwest; this specimen, however, is perhaps somewhat distorted, and there seems to be no reason for recognizing more than a single species among the New Jersey specimens. Most of the specimens are somewhat decidedly subtruncate at the anterior margin and do not seem to differ in any essential respect from the illustrations of *L. subspatulata.*

Formation and locality.—Woodbury clay, Lorillard (102), Crosswicks (168), near Haddonfield (183, 165, 164).

Geographic distribution.—New Jersey, Nebraska, New Mexico, Manitoba.

Order TELOTREMATA.

Family TEREBRATULIDAE.

Genus TEREBRATULA Klein.

Terebratula harlani Morton.

Plate XXVIII., Figs. 1–8.

1829. *Terebratula Harlani* Mort., Am. Jour. Sci., 1st ser., vol. 18, p. 250, pl. 3, fig. 16; vol. 17, p. 283.

1829. *Terebratula Harlani* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 73, pl. 3, figs. 1-4.

1829. *Terebratula perovalis* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 77, pl. 3, figs. 7-8. (Not *T. perovalis* Sowerby.)

1834. *Terebratula Harlani* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 70, pl. 3, fig. 1, pl. 9.

1834. *Terebratula camilla* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 70.

1853. *Terebratula Harlani* Marcou, Expl. Text to Geol. Map U. S. and Brit. Prov. N. A., p. 47, pl. 7, fig. 8.

1861. *Terebratula Harlani* Gabb, Proc. Acad. Nat. Sci. Phil., 1861, p. 18.

1861. *Terebratula atlantica* Gabb, Synop. Moll. Cret. Form., p. 250 (194).

1861. *Terebratula Harlani* Gabb, Synop. Moll. Cret. Form., p. 252 (196).

1868. *Terebratula Harlani* Cook, Geol. N. J., p. 375, two figs.
1868. *Terebratula Harlani* Con., Cook's Geol. N. J., p. 723.
1870. *Terebratula Harlani* Credner, Zeitsch. d. Deutsch. Geol. Gesell., vol. 22, p. 221.
1886. *Terebratula Harlani* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol 9), p. 6, pl. 1, figs. 15-23.
1891. *Terebratula gorbyi* Miller, Adv. Sheets 17th Rep. Geol. Surv. Ind., p. 77, pl. 13, figs. 3-4.
1892. *Terebratula gorbyi* Miller, 17th Ann. Rep. Dept. Geol. and Nat. Res. Indiana, p. 687, pl. 13, figs. 3-4.
1898. *Terebratula harlani* Bagg, Am. Geol., vol. 22, p. 370.
1901. *Terebratula harlani* C. and M., Md. Geol. Surv., Eocene, p. 204, pl. 58, figs. 2-3.
1905. *Terebratula harlani* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—Shell large, the dimensions of a large individual being: length, 59 mm.; width, 36 mm.; thickness, 36 mm.; elongate oval in outline with subparallel sides, often becoming more or less cylindrical in old specimens; the front margin more or less truncated, sometimes bilobate from a flattening or lobing of the valves anteriorly. Pedicle valve very ventricose, becoming almost gibbous in old individuals, the beak large, strong, incurved, truncated at the apex by the large foramen whose diameter is greater externally than within, the truncation in full-grown shells being parallel with the axis of the valves; lateral margins of the beak subangular; the median portion of the valve often flattened or somewhat concave toward the front and the lateral slopes sometimes impressed. Brachial valve much less convex than the pedicle, the beak small and strongly incurved; the median portion of this valve flattened or concave anteriorly, the flattened portion being bounded on each side by a more or less distinct angular ridge which separates it from the lateral slope, this feature often being exaggerated to so great an extent as to give the anterior half of the shell a decidedly plicate appearance; internally the crura are slender near their junction with the valve, and expand rapidly to form a broad loop from 8 mm. to 15 mm. in length, with the

width more than two-thirds of the length, the loop sharply angular at the points of recurvature. Surface of both valves marked by numerous lines of growth which are often crowded towards the front of old specimens so as to form distinct varices. Shell substance finely punctate, the punctæ usually visible under a hand lens, always more distinctly seen upon exfoliated surfaces.

Remarks.—This species is perhaps the largest Terebratuloid shell known in any of the American faunas, and at the horizons where it is found in the Cretaceous formations of New Jersey it usually occurs in great numbers. It usually forms a very constant bed at the summit of the Hornerstown marl where, through several feet of sediments, the shells occur almost to the exclusion of everything else. The species also occurs in the quartz sand facies of the Vincentown formation, sometimes in great numbers, but always in the form of internal casts.

The specimen described by S. A. Miller as *Terebratula gorbyi*, said to come from the Keokuk group at Edwardsville, Indiana, is only an example of *T. harlani*. The type of this species, now preserved in the Paleontological Collection of the Walker Museum at the University of Chicago, is a typical greensand specimen and never could have been collected from any Keokuk or even any Paleozoic formation of America. Its true locality can of course not be determined, but it has every appearance, lithologically and otherwise, of the specimens which occur in the Hornerstown marl near New Egypt, New Jersey, and it is not improbable that the specimen originally came from that locality.

Formation and locality.—Hornerstown marl, near New Egypt (142², 142³), near Mullica Hill (182), near Woodstown (181); Vincentown formation, near New Egypt (146), near Deal (122), near Eatontown (111).

Geographic distribution.—New Jersey; ? Eocene of Maryland.

Terebratula harlani var. fragilis Morton.

Plate XXVIII., Figs. 4–6.

1829. *Terebratula fragilis* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 75, pl. 3, figs. 3-4, (Not *T. fragilis* Schloth.).

1829. *Terebratula fragilis* Mort., Am. Jour. Sci., 1st ser., vol. 17, p. 283; vol. 18, p. 250, pl. 3, fig. 17.
1834. *Terebratula fragilis* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 70, pl. 3, fig. 2.
1886. *Terebratula Harlani* var. *fragilis* Whitf., Pal. N. J., vol. 1, (Monog. U. S. G. S., vol. 9), p. 7, pl. 1, figs. 15-18.

Description.—The name *fragilis* was applied by Morton to those specimens of *T. harlani* which are more conspicuously plicated anteriorly than usual. There is no sharp line of demarcation between the variety and the more typical form of the species, all intermediate variations being met with, and all of them occurring together. It will, perhaps, be a matter of convenience to recognize this form under a varietal name, and if this is done, Morton's name *fragilis* takes precedence, although it has no especial significance, the shells being no more fragile than those of the typical *T. harlani.*

Genus TEREBRATULINA d'Orbigny.

Terebratulina atlantica (Morton).

Plate XXVIII., Figs. 9–12.

1842. *Terebratula atlantica* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 8, p. 214.
1861. *Terebratulina Halliana* Gabb, Proc. Acad. Nat. Sci. Phil., 1861, p. 19.
1861. *Terebratulina Halliana* Gabb, Synop. Moll. Cret. Form., p. 256 (200).
1864. *Terebratulina Halliana* Meek, Check List Inv. Foss N. A., Cret. and Jur., p. 5.
1868. *Terebratula glossa* Con., Cook's Geol. N. J., p. 377, figure; p. 723.
1868. *Terebratulina Halliana* Con., Cook's Geol. N. J., p. 724.
1869. *Terebratula glossa* Con., Am. Jour. Conch., vol. 5, p. 42, pl. 1, fig. 22.
1886. *Terebratulina Atlantica* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 9, pl. 1, figs. 10-13.
1892. *Terebratulina atlantica* Hollick, Trans. N. Y. Acad. Sci., vol. 11, p. 98, pl. 1, fig. 8.

1905. *Terebratulina atlantica* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—The dimensions of two specimens are: length, 22 mm. and 16 mm.; width, 16.5 mm. and 13 mm.; thickness, 12 mm. and 8 mm. Shell subovate in outline, the greatest width at about the mid-length, the valves subequally convex. Pedicle valve strongly convex, with a large prominent beak perforated by a large foramen; flattened or slightly concave along the median line. Brachial valve nearly as convex as the pedicle, usually somewhat elevated along the mesial line into a rather broad, ill-defined fold which is more or less flattened on top, and from which the surface slopes somewhat abruptly to the lateral margins. Surface of the shell marked by numerous, fine, radiating striæ, which are visible upon the surface of the internal casts with the aid of a hand lens. Shell structure strongly punctate, the punctæ leaving their imprint upon the surface of the internal casts.

Remarks.—This species has only been observed in the Hornerstown and Manasquan marl, and it is the only brachiopod so far known from that horizon. Its usual condition of preservation is in the form of internal casts, but even these specimens preserve, toward the margin of the shell, the fine radiating striæ which are characteristic of the species. It can be easily distinguished from *T. harlani,* the only other brachiopod from New Jersey which is at all similar in form, by its much smaller size, the absence of the subparallel lateral margins, and the fine radiating striæ.

Formation and locality.—Hornerstown marl, near New Egypt (142[1]); Manasquan marl, Farmingdale (138), Shark River (Whitfield).

Geographic distribution.—New Jersey.

Family TEREBRATELLIDAE.

Sub-family MEGATHYRINAE.

Genus CISTELLA Gray.

Cistella beecheri Clark.

Plate XXVII., Figs. 14–17.

1895. *Cistella beecheri* Clark, John Hopkins Univ. Circ., vol. xv, No. 121, p. 3, Plate, figs. C^1-C^2.

Description.—Shell small, plicated, with the plications of the two valves opposite instead of alternate, the front margin of the shell being produced into tooth-like serrations where the plications terminate; subpentagonal in outline, attaining a length and breadth of from 1 mm. to 3 mm., the two dimensions usually being nearly equal; the greatest width usually along the hinge-line, but sometimes between that line and the front of the shell. Pedicle valve strongly convex, with a prominent beak marked by three or four strong, rounded plications upon each lateral slope, and in the larger individuals by an additional mesial plication which originates somewhat abruptly near the mid-length of the shell and continues to the anterior margin; cardinal area sharply defined, triangular, nearly flat or slightly concave, with a strong backward slope, and with a large triangular delthyrium. Brachial valve much flatter than the pedicle, somewhat compressed towards the cardinal extremities and with a distinct mesial flattening or sinus-like depression; marked by plications similar to those of the pedicle valve; internally the brachial valve has a strong median septum, the remaining portions of the brachidium not observed. Shell substance strongly punctate, and the surface of each valve marked by one or two somewhat conspicuous lines of growth.

Remarks.—This little shell is frequently met with in the washings from the Vincentown limesand, near Vincentown, but it is easily overlooked because of its small size. With the exception of the imperfectly known *C. plicatilis,* which is associated with it, this is the only known American species of the genus *Cistella.*

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Cistella plicatilis Clark.

1895. *Cistella plicatilis* Clark, Johns Hopkins Univ. Circ., vol. xv., No. 121, p. 3, Plate, fig. D.

Description.—Pedicle valve unknown. Brachial valve attaining both a length and width of 4.5 mm. in the type specimen; orbicular in outline, slightly convex, with 10 or 12 plications,

which reach to the umbo, besides several short intercalated ones near the front margin; internally a medium septum is strongly developed.

Remarks.—This species has not been met with in the recent collections, and was originally described from a single, somewhat imperfect brachial valve. It is undoubtedly allied to *C. beecheri,* with which it is associated, but it appears to be distinguished from that more frequent species by its larger size and its more nearly orbicular outline.

Formation and locality.—Vincentown limesand, Vincentown (Clark).

Geographic distribution.—New Jersey.

Sub-family DALLININAE.

Genus PLATIDIA Costa.

Platidia cretacea n. sp.

Plate XXVII., Figs. 18–19.

Description.—Shell minute, the dimensions of the largest specimen observed being: Length, 1.76 mm.; and width, 1.66 mm.; subovate in outline with the valves subequally depressed convex, so that the form of the entire shell is lenticular. Surface of the valves smooth, the shell structure minutely punctate. Pedicle valve with a prominent cardinal area which is bisected by a large open foramen; brachial valve with a large pedicle incision about equal in size to that of the opposite valve. Internal features of the shell not observed.

Remarks.—This little brachiopod shell occurs rarely in the washings from the Vincentown limesand. It resembles *P. marylandica* from the Eocene of Maryland, but is much smaller.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey.

Sub-family MAGELLANINAE.

Genus TEREBRATELLA d'Orbigny.

Terebratella plicata (Say).

Plate XXVII., Figs. 1–11.

1820. *Terebratula plicata* Say, Am. Jour. Sci. 1st ser., vol. 2, p. 43.
1829. *Terebratula plicata* Say, Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 73, pl. 3, figs. 5-6.
1834. *Terebratula Sayi* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 71, pl. 3, figs. 3-4.
1845. *Terebratula Sayi* Mort., Am. Jour. Sci. 1st ser., vol. 48, p. 283.
1861. *Terebratella plicata* Gabb, Synop. Moll. Cret. Form., p. 249 (193).
1864. *Terebratella plicata* Meek, Check List Inv. Foss. N. A., Cret and Jur., p. 5.
1868. *Terebratella plicata* Con., Cook's Geol. N. J., p. 375, figure; p. 723.
1870. *Terebratella plicata* Credner, Zeitsch. d. Deutsch. Geol. Gessell., vol. 22, p. 224.
1886. *Terebratella plicata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 12, pl. 1, figs. 5-9.
1905. *Terebratella plicata* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 6.

Description.—Shell subcircular or subovate in outline, pointed posteriorly and rounded in front, strongly plicated, each valve marked by from 8 to 12 or more sharply angular plications which extend to the beak; usually a little wider than long but sometimes longer than wide; the dimensions of four specimens are: length, 14.5 mm., 15.5 mm., 19 mm., 17.5 mm.; width, 16 mm., 15 mm., 20 mm., 16.3 mm.; thickness, 8 mm., 9 mm., 10 mm., 9.5 mm. Pedicle valve strongly convex, with a small, nearly erect beak; cardinal area of moderate size, sharply defined, slightly concave, with a broad delthyrium partially closed

by a pair of deltidial plates leaving a large circular foramen; interiorly the diductor muscular impressions are rather strong and flabellate, occupying the upper third of the valve which is considerably thickened. Brachial valve flattened or but moderately convex, often with a broad, ill-defined mesial sinus usually occupied by a single strong plication, but sometimes by from three to five smaller ones; internally the valve is much thickened in the cardinal region, the cardinal process is prominent, being bilobed or trilobed, with the hinge-plates well developed on either side, the crura originate in front of and between the bases of the hinge-plates at a moderate distance apart, they are directed forward and outward, each one giving origin to a crural process a short distance from the hinge-plate, which points inward and forward, the brachidium is formed by rather broad primary lamellæ which curve outward from the crural extremities and describe an incomplete subcircle of nearly one-half the diameter of the valve; anteriorly they are sharply recurved and returned at a short distance above the main portions, being united by a transverse band just in front of the crural processes; the main portions of the loop are united to the median septum which originates in front of the cardinal process, by a transverse plate near the end of the septum and just in front of the middle of the loop. Surface of the shell marked by numerous strong concentric lines of growth crossing the plications. Shell structure strongly and minutely punctate, the punctæ arranged in quincunx.

Remarks.—Specimens in which the brachidium of this species can be observed are not common, but those which have been observed show that this structure varies considerably in the proportions of its different parts. The species is especially characteristic of the Navesink marl where it sometimes occurs in great numbers, and has not been observed in any other formation. It is not closely related to any other American form except *T. vanuxemi* from which it can be easily distinguished by its strongly angular plications.

Formation and locality.—Navesink marl, Atlantic Highlands (108), Middletown (113^2), near Oak Hill (121), near Crawford's Corner (126^7), near Holmdel (128^3, 128^5, 127, 194),

Marlboro (131), near Walnford (148, 149, 147[4], 195), near Jacobstown (150), near Mount Laurel (166), Mullica Hill (169[2]).

Geographic distribution.—New Jersey.

Terebratella vanuxemi (Lyell and Forbes).

Plate XXVII., Figs. 12–13.

1844. *Terebratula Vanuxemi* L. & F., Proc. Geol. Soc. Lond., 1844, p. 308, with figures.
1845. *Terebratula Vanuxemiana* L. & F., Quart. Jour. Geol. Soc. Lond., vol. 1, p. 62, three text figures.
1861. *Terebratella Vanuxemiana* Gabb, Proc. Acad. Nat. Sci. Phil., 1861, p. 19.
1861. *Terebratella Vanuxemi* Gabb, Synop. Moll. Cret. Form., p. 250 (194).
1864. *Terebratella Vanuxemi* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 5.
1868. *Terebratella Vanuxemi* Con., Cook's Geol. N. J., p. 724.
1886. *Terebratella Vanuxemi* Whitf., Pal. N. J., vol. 1, (Monog. U. S. G. S., vol. 9), p. 14, pl. 1, figs. 1-4.
1892. *Terebratella Vanuxemi* Hollick, Trans. N. Y. Acad. Sci., vol. 11, p. 98, pl. 1, fig. 6.

Description.—Shell subovate in outline, pointed posteriorly and rounded anteriorly, each valve marked by from 15 to 23 rather faint, rounded plications, some of which divide in passing from the beak to the front margin; longer than wide, the dimensions of two individuals being: length, 16 mm., 11.5 mm.; width, 14 mm., 11 mm.; thickness, 8.5 mm., 5.2 mm. Pedicle valve rather strongly convex, usually somewhat flattened along the median line, with a small, nearly erect beak, the cardinal area of moderate size, sharply defined, slightly concave, with a broad delthyrium partially closed by a pair of deltidial plates, leaving a large foramen. Brachial valve depressed convex in younger individuals, becoming more convex with age, so that in some old examples the convexity is almost as great as that of the pedicle valve, usually with a more or less ill-defined mesial flat-

tening or shallow sinus occupied by from two to four plications. Surface of the shell marked at intervals by rather strong, concentric lines of growth. Minute structure of the shell strongly punctate.

Remarks.—This species has its closest relations with the associated *T. plicata,* but it may be easily distinguished from that species by its smaller size, its more elongate form, its more numerous and fainter plications, and usually in the larger individuals by the more strongly convex brachial valve. Both these species occur in the Navesink marl, and neither has been found in any other horizon. *T. vanuxemi* is much the rarer form, and in its typical form has not been observed to occur actually in association with *T. plicata,* but in a bed several feet beneath the horizon of that species.

Formation and locality.—Navesink marl, near Holmdel (128[3]), Crosswicks Creek (195).

Geographic distribution.—New Jersey.

CHAPTER VI.

Branch MOLLUSCA.

Class PELECYPODA.

Order PRIONODESMACEA.

Super-family NUCULACEA.

Family NUCULIDAE.

Genus NUCULA Lam.

Nucula percrassa Conrad.

Plate XXIX., Figs. 1–5.

1858. *Nucula percrassa* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 327, pl. 35, fig. 4.

1860. *Leda slackiana* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 397, pl. 69, fig. 36.

1861. *Leda slackiana* Gabb, Synop. Moll. Cret. Form., p. 189 (133).

1861. *Nucula percrassa* Gabb, Synop. Moll. Cret. Form., p. 205 (149).

1864. *Nuculana slackiana* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 8.

1864. *Nucula percrassa* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 8.

1868. *Nucula percrassa* Con., Cook's Geol. N. J., p. 725.

1868. *Nucula slackiana* Con., Cook's Geol. N. J., p. 725.

1869. *Donax fordii* Con., Am. Jour. Conch., vol. 5, p. 102, pl. 9, fig. 25.

1876. *Nucula percrassa* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 318.

1876. *Nucula slackiana* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 318.

1886. *Nucula percrassa* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 102, pl. 11, figs. 4-6.
1886. *Nucula slackiana* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol 9), p. 103, pl. 11, figs. 2-3.
1886. *Donax fordii* Whitf., Pal. N. J., vol 1 (Monog. U. S. G. S., vol. 9), p. 171, pl. 23, fig. 1.
1905. *Nucula percrassa* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 7.
1905. *Nucula slackiana* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 8.
1905. *Donax fordii* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 17.

Description.—Shell moderately convex, attaining a large size for the genus, the largest New Jersey specimen observed being: length, 32 mm., and height about two-thirds the length. Shell subelliptical in outline, the beaks situated at about the anterior third of the shell, the greatest length of the shell at about the mid-height. Anterior margin obliquely subtruncate above, the anterior extremity of the shell subangular; basal margin between the two extremities of the shell usually regularly rounded, sometimes more or less obscurely obliquely subtruncate in front and sometimes somewhat straightened ventrally; posterior margin more or less sharply rounded; the postero-dorsal margin gently convex or nearly straight. Valves regularly convex, antero-dorsal slope rather abrupt, passing into the rather large lunular depression. Surface of the shell marked by more or less irregular concentric lines of growth, and by fine, regular, radiating costæ, narrower than the interspaces, which are more strongly developed on the anterior portion of the shell. The shell substance thick. Teeth strong, about 20 posterior and 8 or 10 anterior to the beak, both series diminishing in size as they approach the beak. Well preserved internal casts preserve strongly defined muscular impressions and pallial line, and are strongly crenate about the free margin.

Remarks.—This species occurs more or less commonly in several of the Cretaceous formations of New Jersey, and presents several different aspects because of the different modes of preser-

vation. In the Marshalltown marl near Swedesboro, the shell substance is perfectly preserved, but in other localities the specimens are usually more or less modified internal casts and external impressions. Only rarely is an internal cast met with which preserves well the muscular impressions and other markings of the interior of the shell. In most cases, after the dissolution of the shells, the soft material in which they were buried has been compressed, closing the cavities left by the shells and obliterating the natural markings of the casts.

Whitfield considered the two species, *N. percrassa* and *N. slackiana* as distinct, but a careful study of a large number of specimens from New Jersey, and a comparison of them with southern representatives, has shown that it is absolutely impossible to draw any lines which can be used to distinguish the two forms. Gabb himself, the author of the species *N. slackiana* gave expression to the same conclusion in 1876.

A careful examination of the type of *Donax fordii* Con., in the collection of the Philadelphia Academy of Science, shows it to be only an imperfect and somewhat distorted example of *Nucula percrassa.*

Formation and locality.—Cliffwood clay, Cliffwood Point (105); Merchantville clay-marl, near Jamesburg (141), Lenola (163), Merchantville (162); Woodbury clay, Lorillard (102), near Haddonfield (183); Marshalltown clay-marl, near Swedesboro (177); Wenonah sand, near Marlboro (130).

Geographic distribution.—New Jersey, Maryland, North Carolina, Alabama, Mississippi and Texas.

Nucula whitfieldi n. sp.

Plate XXIX., Figs. 6–12.

Description.—Shell triangularly subovate in outline, with moderately convex valves; the beaks pointed, situated from one-fifth to one-fourth the length of the shell from the anterior extremity; postero-dorsal margin moderately convex from the beak to the somewhat sharply rounded posterior extremity of the shell which is below the mid-height; ventral margin convex throughout, curving upward more rapidly in front than behind;

anterior margin rounded; antero-dorsal margin sloping somewhat abruptly from the beak. Hinge-line with 20 to 25 teeth posterior to the beak and 10 or 12 in front, with a few small ones directly beneath the beak. Surface of the shell marked by somewhat regular concentric lines. Surface of the casts usually smooth and without marginal crenulations.

The dimensions of a rather large individual from the Wenonah sand are: length, 21 mm; height, 15.5 mm.

Remarks.—This species was at first identified as *Nucula monmouthensis* Whitf., but a study of Whitfield's type of that species has shown it to be a member of the genus *Lima*. A second specimen, in the collection of the Philadelphia Academy of Science which was referred by Whitfield to his *N. monmouthensis,* is apparently identical with the shells here described. The species differs from *N. percrassa* in the absence of radiating costæ upon the external surface of the shell, and in the absence of marginal crenulations.

Formation and locality.—Cliffwood clay, Cliffwood Point (105); Merchantville clay-marl, near Matawan (101[2]), near Jamesburg (140), Lenola (163); Woodbury clay, Lorillard (102), near Matawan (103), near Haddonfield (183), Crosswicks (168); Wenonah sand, near Crawfords Corner (126[3]), near Marlboro (130); Red Bank sand, near Middletown (112), Red Bank (119).

Geographic distribution.—New Jersey.

Family LEDIDAE.

Genus LEDA Schumacher.

Leda compressifrons (Whitfield).

Plate XXIX., Figs. 13–17.

1886. *Nuculana compressifrons* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 109, pl. 11, fig. 9.

Description.—Shell small, the dimensions of an average specimen from Lorillard being: length, 8.5 mm., height 4 mm. Beaks rather prominent, situated near the anterior third of the

shell. Posterior portion of the shell, from the beaks back, subcuneate in outline, the posterior extremity sharply rounded, and just below the extremity the margin is very obliquely subtruncate for a short distance; anterior portion of the shell in front of the beaks subsemielliptical in outline. Hinge-line elongate, the anterior and posterior portions widely divergent, meeting under the beak at an angle of about 140°, the posterior row of teeth, 20 or more in number, the anterior row with about 12 or more teeth. External surface of the shell, as indicated by impressions, perfectly smooth.

Remarks.—This name was first legitimately used by Whitfield, although that author credits it to Conrad. Conrad, however, only applied it as a manuscript name upon a label in the collections of the Philadelphia Academy of Science, and it was never actually published prior to the appearance of Whitfield's monograph. The shells occur commonly in the collection from Haddonfield, from which locality the species was originally described, and also in the same formation in other portions of the State. Whitfield's original illustration of the species is inaccurate in representing the posterior extremity of the shell too squarely truncate. In this character the original specimens from Haddonfield resemble those here illustrated from Lorillard, but the Haddonfield examples are usually a little more pointed than those from Lorillard, a difference which may be due to the difference in the conditions of preservation of the species at the two localities.

Formation and locality.—Merchantville clay-marl, near Jamesburg (139, 140, 141); Woodbury clay, Lorillard (102), Crosswicks (168), near Haddonfield (183, 165).

Geographic distribution.—New Jersey.

Leda pinnaformis Gabb.

Plate XXIX., Fig. 27.

1860. *Leda pinnaforma* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 303, pl. 48, fig. 22.

1861. *Leda pinnaeformis* Gabb, Synop. Moll. Cret. Form., p. 189 (133).

1864. *Nuculana pinnæformis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 8.
1868. *Nuculana pinnaformis* Con., Cook's Geol. N. J., p. 725.
1886. *Nuculana pinnaformis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 108, pl. 11, figs. 7-8.
1905. *Leda pinnaforme* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 8.

Description. Shell small, the dimensions of the type specimen being: length, 6.5; height, 4.7 mm.; cuneate-subovate in outline, the anterior margin rather broadly rounded, the ventral margin rather strongly convex in the middle, the posterior extremity pointed; valves strongly ventricose in the middle, becoming compressed posteriorly. Beaks large and rather prominent, situated about two-fifths of the length of the shell from the anterior extremity; along the postero-cardinal margin the edge of the shell is inflected to form a narrow, nearly linear area extending from the beak to the posterior extremity. Surface of the shell marked by conspicuous, regularly concentric lines which become obsolete at the margin of the linear area along the postcardinal margin. Characters of the hinge-line not observed.

Remarks.—No examples of this shell have been met with in the recent collections of the Survey, and the species is apparently represented by the single individual upon which it was founded. Whitfield illustrated a second specimen and referred it to this species, but this identification is probably incorrect, and the specimen perhaps belongs to the species *L. marlboroensis,* described for the first time in the present report. *L. pinnaformis* may be recognized, should it be met with in future collections, by its short, ventricose form, and its strong, concentric, markings.

Formation and locality.—Woodbury clay, Haddonfield (183).

Geographic distribution.—New Jersey.

Leda marlboroensis n. sp.

Plate XXIX., Figs. 18–23.

Description.—Shell small, the dimesions of a small internal cast being: length, 6 mm.; height, 3.5 mm.; convexity, 1.5 mm. The dimensions of a larger individual are: length, 13.5 mm.;

height, 7.5 mm.; convexity, 2 mm. Beaks rather prominent, directed backward, situated about two-fifths the length of the shell from the anterior end. Anterior portion of the shell in front of the beaks, subsemielliptical in outline, somewhat inflated; posterior portion compressed, rostrate, the postero-dorsal margin concave, the posterior extremity sharply and narrowly rounded, the postero-ventral margin gently convex. Hinge-line elongate, the anterior row of teeth straight, about 12 in number; posterior row slightly concave, with 16 or 18 teeth. Surface of the shell as shown in impressions of the exterior, marked by fine, regular, concentric costæ.

Remarks.—This species was first identified as *L. pinnaformis,* but a careful examination of the type of that species has led to the conclusion that the two forms are distinct. Both are similarly marked by fine, regular, concentric costæ, but *L. marlboroensis* is proportionally a much longer shell, with a more elongate posterior extremity, which is also more conspicuously compressed. Certain examples of *L. marlboroensis,* especially those which are incomplete at the posterior extremity, resemble *L. pinnaformis* very closely, but every individual of the species which is certainly complete posteriorly has the decidedly more elongate form. From all other species besides *L. pinnaformis* in the New Jersey faunas, *L. marlboroensis* may be distinguished by its conspicuously inflated anterior portion and compressed posterior region.

Formation and locality.—Wenonah sand, Crawfords Corner (126[3]), near Marlboro (130).

Geographic distribution.—New Jersey.

Leda protexta Gabb.

Plate XXIX., Fig. 26.

1860. *Leda protexta* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 303, pl. 48, fig. 23. (Not *Leda protexta* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 397, pl. 68, fig. 35.)

1861. *Leda protexta* Gabb, Synop. Moll. Cret. Form., p. 189 (133).

1864. *Uuculana protexta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 8 (in part).
1868. *Nuculana protexta* Con., Cook's Geol. N. J., p. 725.
1876. *Nuculana protexta* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 318.
1886. *Nuculana protexta* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 105, pl. 11, fig. 10.
1905. *Leda protexta* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 8.

Description.—"Shell very elongate and narrow, the narrow end about once and a half as long as the wider and strongly recurved. Valves moderately ventricose and the beaks only moderately elevated; anterior end narrowly rounded and the posterior extremity extended and narrow; basal line gibbous in the middle. On the cast the hinge is seen to be marked by a very large number of small teeth, but the number cannot be made out on any of the several specimens examined. The cartilage pit beneath the beak has been of moderate size. Surface features of the shell unknown." (Whitfield.)

Remarks.—This species is only known from somewhat imperfect internal casts which do not show the external features of the shell. The species differs from any other member of the genus in the New Jersey faunas with a similar outline, in the much more strongly ventricose valves. The species has not been met with in the recent collections of the Survey.

Whitfield has commented on the various uses which have been made of the specific name *protexta* for several closely allied shells of this group. Gabb has used the name twice and Conrad twice for shells which constitute three different species. The name is here used in the same sense as it was used by Whitefield, for the first shell to which the name was given by Gabb, that author's other species being changed to *L. gabbana.* Conrad himself changed the name of one of his species, an Eocene shell, to *L. albaria,* and his other species is the type of the genus *Perrisonota* and retains the specific name *protexta.* Johnson[1] seems

[1] Proc. Acad. Nat. Sci. Phil. (1905), p. 8.

to have considered *Perrisonota protexta* Con. as a synonym of *Leda protexta* Gabb, but they are certainly distinct species, although there is some doubt as to the wisdom of making any generic distinction between them.

Formation and locality.—Navesink marl, Crosswicks Creek and Mullica Hill (Coll. Phil. Acad. Nat. Sci.).

Geographic distribution.—New Jersey.

Leda cliffwoodensis n. sp.

Plate XXJX., Figs. 24–25.

Description.—Shell elongate, the dimensions of a nearly perfect internal cast being: length, 21.5 mm.; height, 9 mm.; thickness, 3.5 mm. The beaks moderately pointed and directed backward, situated about four-tenths of the length of the shell from the anterior extremity. Anterior portion of the shell in front of the beaks, subsemielliptical in outline, postero-dorsal margin concave, posterior extremity subtruncate, rounding rather abruptly below into the gently convex postero-ventral margin. Hinge very long, the anterior portion nearly straight, with about 20 teeth, the posterior portion concave, with 30 or more teeth, the teeth of each series diminishing in size regularly as they approach the beaks, the two series meeting beneath the beaks in a very broadly obtuse angle. Surface of the shell, as indicated by external impressions, smooth.

Remarks.—This species is a common one in the Cliffwood clays. It is an elongate form of rather large size, somewhat similar in general outline to *L. protexta,* but it may always be distinguished from that species by reason of its much more compressed form. The species, perhaps, most closely resembles *Perrisonota protexta,* but it differs from that form in the much more posterior position of the beaks.

Formation and locality.—Cliffwood clay, Cliffwood Point (105, 185), near Matawan (186, 107, 189).

Geographic distribution.—New Jersey.

Leda gabbana (Whitfield).

Plate XXIX., Figs. 28–30.

1860. *Leda protexta* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 397, pl. 68, fig. 35. (Not *L. protexta* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. p. 303, pl. 48, fig. 23.)

1886. *Nuculana Gabbana* Whitf., Pal. N. J., vol. 1, (Monog. U. S. G. S., vol. 9), p. 106, pl. 11, figs. 11-13.

Description.—"Shell of moderate size, extremely elongated, the length being nearly twice and a half the extreme height. Valves convex, regularly and evenly rounded. Beaks small, appressed and incurved, and distinctly inclined toward the narrower end of the shell, scarcely rising above the hinge-line on the wider part, and situated about two-fifths of the length from the larger end. Cardinal margin on the wider end gently arcuate and a little more strongly concave on the narrower side of the beak; large extremity of the shell sharply rounded; basal margin gently rounded throughout and the posterior end narrow and rounded. As the specimen is an internal cast, it preserves no evidences of the surface characters. The muscular scars are extremely faint and the pallial line undistinguishable, although the cast is in an excellent state of preservation and somewhat polished on the surface from the perfect condition. The hinge-line has been marked by a large number of very fine teeth, gradually increasing in size from the center outward. On the wider end of the shell there are about 25 visible under a glass and about 20 somewhat stronger ones on the narrower side of the beak. The ligamental pit has been of moderate size, but well marked and deep." (Whitfield.)

Remarks.—This species has not been met with in the recent collections of the Survey, and the type specimen which is said by Whitfield[1] to be preserved in the collection at Trenton, has apparently been lost or destroyed. The specimens in the recent collections which most nearly approach Whitfield's figure of this

[1] Ann. N. Y. Acad. Sci., vol. 12, p. 161.

species are from the Tinton beds, but they have a much smaller number of teeth than that given by Whitfield.

Formation and locality.—Navesink marl, Freehold (Whitfield).

Geographic distribution.—New Jersey.

Leda tintonensis n. sp.

Plate XXIX., Figs. 31–34.

Description.—Shell small, the dimensions of an internal cast being: length 10 mm., height 5 mm., convexity 1.5 mm. Beaks rather prominent, nearly erect or pointed slightly backward, situated a little over two-fifths of the length of the shell from the anterior extremity. Anterior portion of the shell semielliptical in outline; posterior portion subcuneate behind; the postero-dorsal margin nearly straight or slightly concave; the posterior margin curving downward and forward into the basal margin so that the whole ventral margin from the posterior extremity of the hinge-line to the middle of the anterior margin, describes nearly the arc of a circle. Anterior series of teeth straight or slightly convex, about 10 or 12 in number; posterior series nearly straight or slightly concave, about 15 or 16 in number. Surface of casts smooth, external surface of shell unknown.

Remarks.—In general form and size this little shell agrees with Whitfield's illustration of the type of his *Leda gabbana,* but it differs from that species according to the description, in having much coarser teeth, there being 25 posterior and 20 anterior teeth in that species, which is nearly twice as many as in the shell under discussion.

Formation and locality.—Tinton beds, Beers Hill cut, south of Keyport (129[5]).

Geographic distribution.—New Jersey.

Genus PERRISONOTA Conrad.

Perrisonota protexta Conrad.

Plate XXX., Figs. 1–2.

1869. *Perrisonota protexta* Con., Am. Jour. Conch., vol. 5, p. 98, pl. 9, fig. 24.

1886. *Perrisonota protexta* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol 9), p. 110, pl. 11, figs. 14-15.

1905. *Perrisonota protexta* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 8.

Description.—"Shell small, ensiform, extremely elongated posteriorly, and gradually narrowed from the beaks. Valves depressed convex with very small inconspicuous beaks, which are curved backward, and with an obsolete carination extending from them backward to the postero-basal angle. Anterior end broadest, sharply rounded; posterior end narrowly rounded, longest above the middle. Hinge-line arched upward in front of the beaks, and gently concave posteriorly throughout the entire length of the shell. Basal line moderately curved, more prominent just in advance of the beaks. Surface of the shell polished or marked by very fine concentric lines of growth, except on the posterior cardinal slope, where they unite and form a few inconspicuous folds." (Whitfield.) The impression of the hinge-plate in internal casts shows the presence of 60 or more fine, straight teeth posterior to the beaks, and about 12 much larger and decidedly >-shaped teeth in front.

The dimensions of a large internal cast are: length 26 mm., height 8 mm.

Remarks.—This species has a rather long geologic range in the New Jersey Cretaceous formations, but it seems to be rare everywhere, except in some localities of the Red Bank sand. In all localities, except Haddonfield, this species has been observed only in the form of internal casts, and these do not possess the obscure carination or umbonal ridge passing from the beak to the postero-basal margin. It is doubtful whether the generic name *Perrisonota* should be considered as valid. This species is Conrad's type of the genus, but, except in the extraordinary posterior extension of the shell, which is doubtfully a character of generic value, it does not differ essentially from members of the genus *Leda*.

Formation and locality.—Merchantville clay-marl, near Jamesburg (140, 141), Lenola (163); Woodbury clay, near Haddon-

field (183, 165); Wenonah sand, near Marlboro (130); Red Bank sand, Red Bank (116), Shrewsbury river (119), near Middletown (112); Tinton beds, Beers Hill cut, south of Keyport (129[5]).

Geographic distribution.—New Jersey.

Genus YOLDIA Moller.

Yoldia longifrons (Conrad).

Plate XXX., Fig. 5.

1860. *Leda longifrons* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 281, pl. 46, fig. 18.
1861. *Leda longifrons* Gabb, Synop. Moll. Cret. Form., p. 189 (133).
1864. *Nuculana longifrons* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 8.
1886. *Nuculana longifrons* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 107, pl. 11, figs. 16–17.
1905. *Yoldia longifrons* Johns., Proc. Acad. Nat Sci. Phil. (1905), p. 8,

Description.—The dimensions of an average specimen are: length, 36 mm.; height, 14.5 mm.; convexity, 4.5 mm. Shell longitudinally subelliptical in outline, a little narrower behind than in front. Beaks scarcely elevated above the hinge-line, situated about two-fifths the length of the shell from the anterior extremity. Anterior and posterior cardinal margins sloping away from the beak on either side, meeting in an angle of 150° to 155°; anterior margin broadly rounded, its most anterior extension above the mid-height of the shell; posterior margin more narrowly rounded, its greatest extension above the middle; ventral margin gently convex in the middle, curving upward more sharply at either end. Impression of the hinge-line in the internal cast bearing about 35 or more <–shaped teeth posteriorly in nearly a straight line, and about 25 >–shaped teeth anteriorly, also in a straight line. External surface of the shell polished, marked only by fine, more or less conspicuous concentric lines of growth.

Remarks.—This species has only been found in the Woodbury clay. At Lorillard it is one of the most abundant species, and like so many of the shells at this locality, it attains a much larger size than at Haddonfield. The number of hinge-teeth in the Lorillard specimens is also greater than in those from Haddonfield, but this is doubtless due to their larger size. In some of the internal casts from Lorillard a deep pallial sinus is faintly seen, which gives to the shells the characteristic features of the genus *Yoldia*. The species is a close ally of *Yoldia evansi* M. & H. of the Cretaceous faunas of the interior.

Formation and locality.—Woodbury clay, Lorillard (102), near Matawan (103), Crosswicks (168), near Haddonfield (183, 165, 164).

Geographic distribution.—New Jersey, Mississippi, Arkansas.

Yoldia papyria (Conrad).

Plate XXX., Fig. 6.

1869. *Nucularia papyria* Con., Am. Jour. Conch., vol. 5, p. 44, pl. 1, fig. 7.

1886. *Nucularia papyria* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 111, pl. 11, figs. 18-20.

1905. *Nucularia papyria* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 8.

Description.—The dimensions of a large right valve are: length, 15.5 mm.; height, 9.5 mm.; convexity, 3 mm. Shell subelliptical in outline, strongly convex in the anterior half, becoming rapidly depressed posteriorly. Beak scarcely elevated above the hinge-line, situated a little over one-fifth of the length of the shell from the anterior extremity. Posterior portion of the hinge-line nearly straight, the hinge-plate bearing about 18 >-shaped teeth; the anterior hinge-line much shorter than the posterior, rapidly declining, forming an angle of about 125° with the posterior portion, the hingle-plate bearing about 12 <-shaped teeth. Anterior margin of the shell rounded from just below the beak to a point on the ventral margin directly beneath, the curve being subsemielliptical with the most anterior

point at about the mid-height of the shell; basal margin gently convex, subparallel with the posterior part of the hinge-line; posterior margin rounding from the posterior extremity of the hinge-line, the greatest posterior extension of the shell being above the middle, obliquely convex, subtruncate below and rounding into the basal margin. Surface of the shell nearly smooth, marked only by faint concentric lines of growth.

Remarks.—The types of this species from Haddonfield are scarcely more than one-half the size of the specimens whose dimensions are given above. This fact, however, is in accord with the individuals of many of the Haddonfield species, which grow to a much larger size in the more northern localities. The hinge characters of the Haddonfield specimens have never been properly made out; the fragmentary shells preserving imperfectly the hinge-teeth assigned to this species, and made typical of the genus *Nucularia* belong without doubt to some other species as has been suggested by Whitfield. The internal cast from near Matawan, which is here illustrated, agrees in all the general characters of the shell, except size, with the typical Haddonfield specimens, and there can be no doubt as to their specific identity, but this Matawan specimen preserves very perfectly an impression of the hinge-plate, which shows the dentition to be not fundamentally different from that of the associated *Yoldia longifrons*. The presence or absence of the deep pallial sinus has not been detected in any of the specimens observed, so that it has not been absolutely demonstrated that the species is a member of the genus *Yoldia*, but when the strong general similarity with *Y. longifrons* is taken into account, there is little or no doubt as to its proper generic position.

Formation and locality.—Woodbury clay, near Matawan (103), near Haddonfield (183, 165, 164).

Geographic distribution.—New Jersey.

Yoldia cliffwoodensis n. sp.

Plate XXX., Figs. 3–4.

1905. *Yoldi* cf. *evansi* Weller, Jour. Geol., vol. 13, pp. 239, 331; also Ann. Rep. State Geol. N. J., for 1904, pp. 137, 138. (Not *Y. evansi* M. & H.)

Description.—The dimensions of one of the type specimens are: length, 15.5 mm.; height, 9 mm.; convexity, 2 mm. Shell subelliptical in outline, the valves depressed convex, somewhat compressed in front and behind. Beaks scarcely elevated above the hinge-line, situated about two-fifths the length of the shell from the anterior extremity. Both the anterior and posterior portions of the hinge-line straight or nearly straight, the posterior portion with 20 or more teeth, the anterior portion declining from the beak at an angle of about 46° with the posterior portion, with about 15 teeth. Anterior margin of the shell rounding from the anterior extremity of the hinge-line, the greatest extension at about the mid-height of the shell; posterior margin rounding from the posterior extremity of the hinge-line, the greatest extension above the middle; ventral margin, between the most anterior and posterior points of the shell, approaching a longitudinal semiellipse, but with the posterior portion more or less obscurely obliquely subtruncate. Surface of the shell smooth, as indicated by impressions of the exterior.

Remarks.—This species resembles *Y. longifrons* of the Woodbury clay, but is proportionately shorter with the basal margin more strongly curved and the anterior and posterior portions of the hinge-line forming less nearly a straight line; it has not been observed to grow as large as the larger individuals of *Y. longifrons* from Lorillard. The species also resembles *Y. evansi* M. & H., from the Cretaceous beds of the interior, but it differs from that species as illustrated by Meek[1] in much the same way that it differs from *Y. longifrons*, *Y. longifrons* and *Y. evansi* probably being more closely allied than *Y. cliffwoodensis* and *Y. evansi*.

Formation and locality.—Cliffwood clay, Cliffwood Point (105, 185), near Matawan (107).

Geographic distribution.—New Jersey.

[1] Rep. Inv. Cret. and Ter. Foss. Up. Mo., p. 111, pl. 28, figs. 10 a-c.

Super-family ARCACEA.

Family PARALLELODONTODAE.

Genus NEMODON Conrad.

Nemodon eufaulensis (Gabb).

Plate XXX., Figs. 8–11.

1860. *Arca (Macrodon) eufalensis* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser. vol. 4, p. 398, pl. 68, fig. 38. (Not *Nemodon eufaulensis* Con.)

1861. *Arca Eufalensis* Gabb, Synop. Moll. Cret. Form., p. 152 (96).

1868. *Arca Eufalensis* Con., Cook's Geol. N. J., p. 725.

1886. *Nemodon Eufaulensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 83, pl. 12, figs. 3-4 (not fig. 5).

Description.—"Shell small, seldom reaching a length of one inch in the extreme. Form trapezoidal, the cardinal and basal margins subparallel, and the length about twice and a half as great as the height. Anterior end obliquely and rapidly receding from the extremity of the hinge and most rapidly on the lower half; posterior end obliquely truncate, prolonged backward below to the umbonal angle. Valves moderately ventricose, with a decidedly angular umbonal ridge behind, and a shallow mesial depression extending from the beaks to the basal border, slightly affecting the basal line near the middle of its length. Beaks large and rather prominent, situated at about the anterior third of the length. Area moderate. Surface marked by numerous fine radiating striæ showing upon the cast, which are a little coarser near the posterior angle and on the cardinal slope, possibly somewhat alternating in size on the anterior end, but indistinctly showing this feature on the internal cast. Hinge-line marked by two distinct linear teeth on the anterior end parallel to the hinge. Those of the rest of the hings have not been observed." (Whitfield.)

Remarks.—The Haddonfield specimens referred to this species by Conrad and made the type of the genus *Nemodon,* are con-

sidered by Johnson to be distinct from the typical form of the species described by Gabb from Eufaulia, Alabama, and he has proposed the name *Nemodon conradi* for them. Whitfield's description of the species was drawn up from a specimen from the Navesink marl, but he also referred the Haddonfield specimens of Conrad to the same species and illustrated one individual from that locality. *N. eufaulensis* seems to differ from *N. conradi* in the greater extension of the hinge-line anterior to the beak, in the more angular umbonal ridge, and in the stronger sinus extending from the beak to the ventral margin. The species as here recognized in the New Jersey faunas is represented by the Navesink specimen described and illustrated by Whitfield. The same form occurs abundantly in the Red Bank sand in the recent collections of the Survey, and rarely in the Merchantville clay-marl. The Red Bank examples vary considerably in size, at some localities small individuals 10 mm. to 12 mm. in length being the only ones recognized, while in other localities they are larger, reaching a length of 20 mm. more or less. In Whitfield's description it is stated that the posterior hinge-teeth have not been observed, but recently collected specimens show them to be two or three in number, parallel with the hinge-line and similar to the anterior teeth but more elongate.

The writer has felt no little hesitation in recognizing the several species of the genus *Nemodon* included in the present report. *N. eufaulensis* and *N. conradi* especially seem to be almost too closely allied to be given separate specific recognition, and the internal cast described by Gabb as *N. angulatum* might well be a somewhat aberrant or distorted individual of the same species. The specimens referred to *N. brevifrons* seem to be more worthy of separate specific recognition, but even these might possibly be referred to a common species. The exact determination and definition of these several species cannot be made with the material now available for study, and had not these species already received recognition in the literature, no attempt would have been made in this place to differentiate more than two of them at the most.

Formation and locality.—Merchantville clay-marl, near Jamesburg (139, 140, 141), Lenola (163); Marshalltown clay-marl, near Swedesboro (177); Navesink marl, Holmdel (Whitfield),

near Walnford (148[2]), near Jacobstown (150); Red Bank sand, Red Bank (116), Shrewsbury River (119), near Middletown (112); Tinton beds, Beers Hill Cut, south of Keyport (129[9]).

Geographic distribution.—New Jersey, Georgia, Alabama, Mississippi, Arkansas.

Nemodon conradi Johnson.

Plate XXX., Fig. 7.

1867. *Trigonarca eufalensis* Con., Am. Jour. Conch., vol. 3, p. 9. (Not *Arca eufalensis* Gabb.)
1869. *Nemodon eufaulensis* Con., Am. Jour. Conch., vol. 5, p. 97, pl. 9, fig. 16.
1886. *Nemodon eufaulensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 83, pl. 12, fig. 5 (not figs. 3-4).
1905. *Nemodon conradi* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 9.

Description.—Shell subrhomboidal in outline, the dimensions of a nearly complete right valve being: length, 16.8 mm.; height, 9 mm.; length of hinge-line, 12 mm. The valves moderately convex, with the beaks somewhat incurved and situated at about the anterior third of the total length of the shell, the umbo produced a little beyond the hinge-line. Hinge-line straight; the anterior margin making an obtuse angle with the hinge-line, broadly rounding into the slightly convex ventral margin, the ventral margin curving rather sharply posteriorly into the obliquely subtruncate posterior margin. Umbonal ridge rounded, the posterior slope rather narrow. Surface of the internal cast marked by concentric and radiating lines of nearly equal strength, giving it a cancellated appearance. Anterior and posterior hingle-teeth both three in number, straight and nearly parallel with the hingle-margin, the posterior ones being slightly longer than the anterior.

Remarks.—The name *N. conradi* has been proposed by Johnson for certain shells from the Woodbury clay near Haddonfield, which Conrad referred to *N. eufaulensis* many years ago. The Haddonfield specimen referred to *N. eufaulensis* by Whit-

field is also doubtless a member of the same species, although its surface markings have been obliterated. The species differs from *N. eufaulensis* in the shorter anterior extension of the hinge-line, and consequently in the more regularly rounded anterior margin, in the more rounded umbonal ridge, and in the less conspicuous sinus extending from the beak to the ventral margin. The two species also seem to differ in the character of their surface markings. The general form of the shell more nearly approaches *N. brevifrons,* but the postero-basal extremity is less extended, the surface markings are different and the anterior hinge-teeth are straighter.

Formation and locality.—Woodbury clay, Lorillard (102), near Haddonfield (183).

Geographic distribution.—New Jersey.

Nemodon angulatum (Gabb).

Plate XXX., Fig. 15.

1860. *Leda angulata* Gabb, Proc. Acad. Nat. Sci. Phil. (1860), p. 95, pl. 2, fig. 12.
1861. *Leda subangulata* Gabb, Synop. Moll. Cret. Form., p. 189 (133).
1864. *Nuculana subangulata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 8.
1868. *Nuculana angulata* Con., Cook's Geol. N. J., p. 725.
1876. *Nemodon angulatum* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 316.
1886. *Nemodon angulatum* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 84, pl. 12, figs. 6–7.
1905. *Nemodon angulatum* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 9.

Description.—Shell small, the dimensions of the type specimen being: length, 15.5 mm.; height, 8 mm.; thickness, 5 mm. Beaks rather prominent, situated at about the anterior third of the shell. Anterior margin broadly curved from beneath the beak to the antero-basal region, where it curves more abruptly into the nearly straight ventral margin, postero-basal margin

produced and subangular, posterior margin truncate, meeting the posterior extremity of the hinge-line in an obtuse angle, dorsal margin nearly straight, sloping gently backward from the beak to the posterior hinge extremity. From the beak a subangular umbonal ridge passes obliquely backward to the postero-basal angle, and a broadly-flattened or slightly sinuate area passes downward from the beak to about the middle of the ventral margin. The surface markings and hinge characters not preserved on the type specimen, which is an internal cast.

Remarks.—The type is the only specimen of this species which has yet been observed. It somewhat resembles *N. eufaulensis,* but the beaks are more prominent and the anterior margin is very different, the most anterior extension of the shell being near the hinge-line in *N. eufaulensis,* while in *N. angulatum* it is near the base. The radiating markings of the shell may usually be distinguished upon the casts of *N. eufaulensis,* which is not the case with this species.

Formation and locality.—Navesink marl, Burlington County (Gabb, Whitfield).

Geographic distribution.—New Jersey.

Nemodon brevifrons Conrad.

Plate XXX., Figs. 12–14.

1875. *Nemondon brevifrons* Con., Kerr's Geol. N. Car., App. A., p. 4, pl. 1, fig. 15.

1886. *Nemodon brevifrons* Whitf., Pal. N. J., vol. 1, (Monog. U. S. G. S., vol. 9), p. 85, pl. 12, figs. 1-2.

1905. *Nemodon brevifrons* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 9.

Description.—Shell of moderate size, the dimensions of a very perfect right valve being: length, 23 mm.; height, 13 mm.; length of hinge-line, 15 mm.; convexity, 6 mm. Shell subrhomboidal in outline, rather strongly convex. Beaks incurved, the umbo rather broad and prominent, and produced above the hinge-line. Hinge-line straight. Anterior margin meeting the hinge-line in an obtuse angle, broadly and evenly rounded, passing with a

regular curvature into the gently convex ventral margin, postero-ventral margin rather broadly rounded and passing into the obliquely subtruncate posterior margin above, which meets the hinge-line in an obtuse angle. The umbonal ridge prominent, broadly rounded or somewhat inflated, the posterior slope being narrow and somewhat abrupt. Surface of the shell marked by concentric lines of growth, and in some specimens by faint radiating lines, which are more conspicuous upon the anterior portion of the shell. The anterior hinge-teeth are three in number, rather short and slightly curved, but nearly parallel with the hinge-line, the posterior teeth are also three in number, perhaps a little longer than the anterior ones, straight and subparallel with the hinge-line.

Remarks.—Johnson states that the specimen of this species described and illustrated by Whitfield as from the Woodbury clay, near Haddonfield, probably did not come from that locality, but from Snow Hill, North Carolina, the type locality for the species. In the recent Survey collections the species has not been recognized in any of the Woodbury clay localities, but it does occur in the Cliffwood clay and the Wenonah sand. In the best specimen observed from the Cliffwood clay the radiating markings of the shell, as shown in an impression of the exterior, are apparently obsolete, the markings being essentially as shown in Conrad's original illustration of the species. One of the specimens from the Wenonah sand, on the other hand, with no essential differences in the contour of the shell, exhibits some faint radiating markings, which are more strongly developed on the anterior portion of the shell, agreeing essentially with Whitfield's description. From the Wenonah sand, near Crawfords Corners, a single specimen of an internal cast has been collected, which agrees closely in general form with the other shells referred to this species, but it is much larger than any other individual observed, being 38 mm. long, and 20 mm. high. It is possible that this specimen should be referred to a distinct species, perhaps undescribed, but in the absence of additional material, especially specimens preserving the external markings, it is thought best to refer it to this species provisionally. The species

differs from *N. conradi,* which is the most nearly related member of the genus in the New Jersey faunas, in its more nearly obsolete radiating surface markings, its more rounded umbonal ridge, and usually in its larger size.

Formation and locality.—Cliffwood clay, Cliffwood Point (105); Wenonah sand, near Marlboro (130), near Crawfords Corners ? (126^3).

Geographic distribution.—New Jersey, North Carolina, Mississippi.

Genus CUCULLAEA Lamark.

Cucullaea antrosa Morton.

Plate XXXII., Figs. 7-9.

1834. *Cucullæa antrosa* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 65, pl. 13, fig. 6.
1861. *Cucullaea antrosa* Gabb, Synop. Moll. Cret. Form., p. 172 (116).
1864. *Cucullæa antrosa* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 8.
1868. *Idonearca antrosa* Con., Cook's Geol. N. J., p. 725.
1872. *Idonearca antrosa* Con., Proc. Acad. Nat. Sci. Phil. (1872), p. 54.
1876. *? Idonearca antrosa* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 315.
1886. *Idonearca antrosa* Whitf., Pal. N. J., vol 1 (Monog. U. S. G. S., vol. 9), p. 96, pl. 13, figs. 6-11
1905. *Cucullaea antrosa* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 8.

Description.—"Shell subcircular in outline, or very slightly ovate from being a little prolonged at the postero-basal angle, very slightly oblique with a straight hinge line, which is about half as long as the greatest length of the shell. Beaks large, erect, and slightly incurved, but not projecting beyond the edge of the proportionally small ligamental area which is marked by oblique grooves, as in all species of the group. Surface of the

shell slightly angulated along the postero-umbonal slope and very convex; marked by numerous strong concentric lines of growth at irregular distances; no radiating striæ. Hinge-plate narrow in small and medium sized specimens and the teeth small, but barely bent down at their inner extremity and few in number; the denticulations along the middle of the hinge vertical and small. On large individuals the outer teeth are strong, from four to five in number on each side, according to the size of the individual; slightly declining outwardly, and the bent portion usually nearly half as long as the horizontal portion, the bending being at an angle within ninety degrees, the denticles on the middle part of the hinge being small and numerous. Muscular scars, as seen on the casts, strongly marked; the impression of the ridge deep, strongly arched, and situated pretty well up on the posterior slope; surface of the cast marked by rather strong vascular lines. The outer margin of the cast is bordered by a strong keel, indicating the great thickening of the valves along the pallial line, which extends around three sides, being broadest on the anterior." (Whitfield.)

The dimensions of a large left valve are: length 75 mm., height 70 mm., convexity 26 mm.

Remarks.—This species may be easily recognized at all times by reason of its subglobose form. Its usual mode of occurrence in New Jersey is in the form of internal casts, and these differ from similar specimens of *C. tippana* in the more rounded outline and the less obliquity of the shell, and in the absence of the conspicuous subangular umbonal ridge with the more or less abrupt postero-dorsal slope of the shell. The species also attains a larger size than *C. tippana*. The species occurs most abundantly in the Merchantville and Navesink formations, it being the most characteristic member of the genus in the first of these formations. The species has not been recognized in any beds higher than the Navesink, its vertical range being quite different in this respect from that of *C. tippana*, which is rare in the Merchantville, and first occurs in abundance in the Marshalltown, and then continues as a conspicuous species up to the Tinton beds, except in the Navesink. Although this species and *C. neglecta* both

occur commonly in the Navesink marl, they are not usually associated in the same locality, for where one of them is present in abundance the other is usually rare or absent altogether.

Formation and locality.—Merchantville clay-marl, Lorillard (120[1]), near Matawan (100[4], 101), Lenola (163); Navesink marl, Atlantic Highlands (108), near Crawfords Corner (126[7]), near Freehold (133), near Walnford (148[2]), Crosswicks Creek (149, 147[3], 147[4], 195), near Jacobstown (150), near Mount Laurel (166); Tinton beds, near Freehold (132).

Geographic distribution.—New Jersey, Texas, Arkansas.

Cucullaea woodburyensis n. sp.

Plate XXXIV., Fig. 1.

Description.—Shell large, the dimensions of the type specimen, the internal cast of a left valve, being: length 75 mm., height 69 mm., convexity 28 mm., length of hinge-line 53 mm. Anterior margin regularly rounding from the anterior extremity of the hinge-line to the middle of the ventral margin, ventral margin less curved in its posterior half, the postero-ventral margin obtusely rounding into the subtruncate posterior margin which is nearly vertical below and curves gently forward to the posterior extremity of the hinge-line above. Beaks of moderate size, those of the two valves approaching somewhat closely. Valves ventricose, without a sharp, umbonal ridge extending to the postero-ventral extremity. Indentation of the posterior muscular ridge rather narrow and of moderate strength.

Remarks.—This species most closely resembles *C. antrosa* of the Merchantville and Navesink faunas, but it is somewhat shorter and more nearly erect in general aspect, besides having, apparently, a much thinner shell, so that the internal cast is not marked by the distinct marginal keel which is so characteristic of that species. The species is a rare one in the Woodbury clay, where a single specimen has been observed.

Formation and locality.—Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey.

Cucullaea tippana Conrad.

Plate XXXI., Figs. 5–10; Plate XXXII., Figs. 1–2.

1858. *Cucullæa tippana* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 3, p. 328, pl. 35, fig. 1.

1861. *Cucullaea tippana* Gabb, Synop. Moll. Cret. Form., p. 174 (118).

1864. *Cucullæa tippana* Meek, Check List Inv. Foss. N. A., Cret and Jur., p. 8.

1886. *Idonearca tippana* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 95, pl. 12, figs. 19–21.

1886. *Idonearca vulgaris* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 95, pl. 12, figs. 19–21.

1905. *Cucullæa tippana* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 8.

Description.—Shell attaining a length of 64 mm., a height of 51 mm., length of hinge-line 41 mm. and convexity of one valve 20 mm., in a large individual. Shell very oblique, subtriangular or subtrapezoidal in outline; umbones prominent, the beaks rather small, incurved, situated at about the middle of the hinge-line; cardinal areas concave, marked by distinct impressed lines about 1 mm. apart, which diverge from beneath the beaks. Anterior margin of the shell curving regularly from the anterior extremity of the hinge-line into the basal margin, which is nearly straight or slightly convex posteriorly; postero-basal extremity rather sharply rounded or subangular; posterior margin obliquely truncate. Surface of the shell most strongly convex along the subangular umbonal ridge, the postero-dorsal slope abrupt, in some individuals being almost vertical. Surface marked by conspicuous, more or less irregular lines of growth, and by fine radiating costæ, which are frequently nearly or quite obsolete. Hinge-plate broad at either end, much narrower under the beaks, with from three to five transversely striate horizontal teeth in front and behind, which are subparallel with the hinge-line and are progressively more elongate from below upward, the inner extremities of one or two of the higher more elongate teeth bend-

ing downward at a sharp angle to the main portion of the tooth, the median two-fifths of the hinge occupied by short, vertical teeth about 10 or 12 in number. The muscular scars on the interior of the shell well-defined, the posterior one bordered along its anterior margin by a narrow, elevated septum; pallial line distinct, the internal surface of the shell above the pallial line marked by more or less indistinct radiating lines.

The internal casts ventricose and very oblique, with the beaks elevated, large and distant, and with a strongly subangular umbonal ridge extending obliquely backward from the beak to the postero-basal extremity. The postero-dorsal slope short and more or less abrupt, the junction of the valves usually strongly keeled when perfect, though this keel is often broken away. The cardinal line curved. The gash in the postero-dorsal slope formed by the septum in front of the posterior muscular impression is deep and often wide in old individuals, extending from the middle of the height of the shell to fully two-thirds the distance between the margin and the beaks. Anterior muscular scar more or less distinct, body of the cast often radially striated.

Remarks.—The description of this species, given above, is drawn from finely preserved individuals in the Marshalltown marl. Among the many perfectly preserved shells of the species in this formation near Swedesboro, considerable variation is exhibited, especially in the abruptness of the postero-dorsal slope. In some individuals this slope is nearly vertical while in others it may be at an angle of nearly 45° to the plane of the valve, these extremes giving to the shells quite different aspects. A rather abrupt, but not quite vertical slope is the commoner, but all intermediate conditions between the two extremes occur. Another variable character is the surface markings of the shell, some individuals being quite rugose in appearance because of the strong concentric lines of growth, while others are much smoother; the radiating costae are also variable, in most cases they can scarcely be detected and in none are they really conspicuous.

The casts which Whitfield has illustrated as *Idonearca vulgaris* are apparently members of this species, but his specimens seem to have been lost or destroyed so that no direct comparison can

be made. They are certainly quite distinct from the true *C. vulgaris*.

A somewhat common *Cucullaea* in the Red Bank sand has been questionably identified as this species, but it usually grows larger than the Marshalltown examples, and judging from the impressions of the exterior the fine radiating costae upon the surface of the shell are more strongly developed and the cardinal areas higher with the beaks consequently more widely separated. In one well preserved impression of the cardinal area from this formation, nine of the diverging furrows may be clearly recognized beneath the beak, while in the Swedesboro specimens only four or five are usually present, and seven is the maximum number which has been observed. Whitfield has identified one of the specimens from the Tinton beds at Beers Hill cut south of Keyport, as *C. tippana*. This locality has furnished a large number of specimens in the recent collections, and although they are for the most part poorly preserved, they present no characters by which they can be separated from the specimens from the Red Bank sand.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177, 179), Marshalltown (190); Wenonah sand, near Marlboro (130); Navesink marl, Atlantic Highlands (108), near Jacobstown (150); Red Bank sand, Shrewsbury River (116, 119); Tinton beds, Beers Hill cut, south of Keyport (129^7, 129^9), near Freehold (132).

Geographic distribution.—New Jersey, Mississippi.

Cucullaea neglecta Gabb.

Plate XXXI., Figs. 1–4.

1861. *Cucullæa neglecta* Gabb, Proc. Acad. Nat. Sci. Phil., 1861, p. 326.

1876. *Idonearca neglecta* Gabb, Proc. Acad. Nat. Sci. Phil., 1876, p. 314.

Description.—Shell oblique, subrhomboidal in outline, the dimensions of a nearly perfect internal cast being: length, 39 mm.; height, 28.5 mm., thickness, 22 mm. Beaks of the internal cast

of moderate size, moderately elevated above the hinge-line, and somewhat approximate for members of this genus. Anterior margin rounding regularly from the anterior extremity of the hinge-line into the gently convex basal margin; postero-basal extremity sharply rounded or subangular; posterior margin obliquely truncate; the free margins somewhat keeled. Valves with a narrowly rounded or subangular umbonal ridge, with the postero-dorsal slope rather steep, indented by the impression of the posterior muscular ridge; anterior muscular impression of only moderate strength; pallial line not sharply defined.

Remarks.—An examination of the types of this species in the collection of the Philadelphia Academy of Science, has shown it to be the common internal cast of moderate size occurring in the Navesink marl. It perhaps agrees most closely with *C. tippana* as known from the Marshalltown clay-marl, but it is a smaller shell with more rounded outlines and with a less abrupt postero-dorsal slope. It has been most commonly referred to *C. vulgaris,* and was apparently so identified by Whitfield, but the types of these two species are very distinct. The species is only known from internal casts.

Formation and locality.—Merchantville clay-marl, Lenola (163); Navesink marl, Crawfords Corner (126[7]), Middletown (113[2]), near Red Bank (120), Atlantic Highlands (108), near Holmdel (127, 128[5]), Marlboro (131), Mullica Hill (169).

Geographic distribution.—New Jersey, Alabama.

Cucullaea vulgaris Morton.

Plate XXXII., Figs. 5–6.

1830. *Cucullæa vulgaris* Mort., Am. Jour. Sci., 1st ser., vol. 17, p. 285, vol. 18, pl. 3, fig. 21.

1830. *Cucullæa vulgaris* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 199.

1834. *Cucullæa vulgaris* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 64, pl. 3, fig. 8, pl. 13, fig. 5.

1861. *Cucullæa vulgaris* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 326.

1861. *Cucullaea vulgaris* Gabb, Synop. Moll. Cret. Form., p. 174 (118).

1864. *Cucullæa vulgaris* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 8.

1868. *Idonearca vulgaris* Con., Cook's Geol. N. J., p. 725, p. 376, figure.

1876. *Idonearca vulgaris* Gabb, Proc. Acad. Nat. Sci. Phil., 1876, p. 313.

1886. *Idonearca medians* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 199, pl. 26, figs. 5-6.

1905. *Cucullæa vulgaris* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 8.

Description.—Internal casts subtriangular in outline, subcuneate behind; the dimensions of a large, nearly perfect specimen, are: length, 40 mm.; height, 32 mm.; thickness, 32 mm. Shell very oblique, the beaks of the internal cast large, widely separated and greatly elevated above the hinge-line. Anterior margin curving backward and downward from the anterior extremity of the hinge-line into the gently convex basal margin; postero-basal extremity prominent, sharply rounded or subangular; posterior margin obliquely truncate. Valves with a strong, angular umbonal ridge, becoming especially prominent towards the postero-basal extremity; the postero-dorsal slope abrupt, indented by the deep and strong, crescentiform cavity left by the posterior muscular ridge. Anterior muscular impression of moderate strength. Pallial line usually strongly defined, especially posteriorly, represented in the casts by an elevated ridge crossed by sharply defined elevated ridges which are short and close anteriorly, becoming longer, stronger and more distant posteriorly, especially where the pallial line crosses the umbonal ridge.

Remarks.—The original examples of this species consist of sixteen specimens in the collection of the Philadelphia Academy of Science, accompanied by Morton's original label, and one of them was undoubtedly the individual used as the original for his figure of the species, although it is not possible to determine which one was actually the type specimen used for illustration

because of the crudeness of the drawing. These original specimens, however, show conclusively that the species is the one which sometimes occurs so commonly in the Hornerstown marl, to which Whitfield gave the name *Idonearca medians*. The casts referred to *Idonearca vulgaris* by Whitfield are quite different and probably should be referred to *C. tippana*. The species resembles in some respects the internal casts of *C. tippana*, but it is more oblique with the beaks longer and more prominent, with the posterior muscular ridge usually more prominent, and with the pallial line much more conspicuous and marked by the strong transverse ridges. The species is known only in the form of internal casts so that the external characters of the two species cannot be compared. The beaks of *C. vulgaris*, however, were undoubtedly more widely separated and the cardinal areas wider. The species, so far as it has been observed in the recent collections, is a characteristic form of the Hornerstown marl horizon, and it is possibly a genetic successor of *C. tippana* of the earlier faunas.

Formation and locality.—Hornerstown marl, J. S. Cook's pits, Tinton Falls (Whitfield), near Hornerstown (152).

Geographic distribution.—New Jersey.

Cucullaea compressirostra (Whitfield).

Plate XXXII., Figs. 3–4.

1886. *Idonearca compressirostra* Whitf., Pal. N. J., vol. 1, (Monog. U. S. G. S., vol. 9), p. 199, pl. 26, figs. 15-16.

Description.—Internal casts subtriangular in form, small, the dimensions of a nearly perfect individual being: length 26 mm., height 21.5 mm., thickness 16 mm. Anterior margin curving regularly downward and backward from the anterior extremity of the hinge-line into the moderately curved basal margin, postero-basal extremity rounding somewhat abruptly into the gently convex, obliquely subtruncate posterior margin. Beaks of moderate size, moderately elevated and approximate. Umbonal ridge rounded, postero-dorsal slope making an angle of about 45° with the plane of the valve. Muscular scars faintly

marked, the pallial line distinct. The indentation of the posterior muscular ridge rather slight.

Remarks.—The specimens referred to this species are all from the Hornerstown marl, and in all cases observed are associated with the casts of *C. vulgaris.* They have very strongly the aspect of immature shells, and although they are widely different from the casts of the associated *C. vulgaris,* it is not impossible that they are immature individuals of that species. In order to determine the real relations of these shells, and whether *C. compressirostra* is a really valid species or not, a much larger series of specimens than are now available must be studied. Whitfield's type of this species is injured along the posterior margin, and in his restoration he has made the shell much more quadrangular in outline than it really was originally.

Formation and locality.—Hornerstown marl, J. S. Cook's pits, Tinton Falls (Whitfield), near Hornerstown (152).

Geographic distribution.—New Jersey.

Cucullaea littlei (Gabb).

Plate XXXIII., Figs. 1–2.

1876. *Idonearca littlei* Gabb, Proc. Acad. Nat. Sci. Phil., 1876, p. 316.

1905. *Cucullaea littlei* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 9.

Description.—Shell very large, the dimensions of a large internal cast being: length 115 mm., height 89 mm., thickness 100 mm. Anterior margin regularly rounding from the anterior extremity of the hinge-line into the convex ventral margin; postero-basal margin rather bluntly rounded; posterior margin obliquely subtruncate, slightly convex; hinge line arcuate. Beaks large and prominent, widely separated and much elevated above the hinge-line in the cast. Valves strongly ventricose, the umbonal ridge broadly rounded, the postero-dorsal slope abrupt, the posterior surfaces of the two valves meeting at the posterior margin in nearly a plane. Indentation of the posterior muscular ridge

strong and very deep, 12 mm. in the type specimen. Hinge characters not observed.

Remarks.—This is the largest species of the genus, and is represented in the New Jersey collection by a single individual from the Tinton beds, in which the beaks are somewhat more obtuse and the valves more ventricose than in the type of the species in the collection of the Philadelphia Academy of Science. The specimen, however, does not differ essentially from other southern examples of the species in the collection of the National Museum at Washington. The species is characterized by its great size and its strongly ventricose valves. In the absence of an angular umbonal ridge the species resembles *C. antrosa*, but it is more oblique than that species, and is much larger than any specimen of *C. antrosa* that has been observed.

Formation and locality.—Tinton beds, Beers Hill cut, south of Keyport (129[7]).

Geographic distribution.—New Jersey, Georgia.

Genus Trigonarca Conrad.

Trigonarca cliffwoodensis n. sp.

Plate XXX., Fig. 17.

Description.—Shell subtrapezoidal in outline, the dimensions of a large individual being: length, 31 mm.; height, 23 mm.; convexity of one valve, 7 mm. Anterior margin broadly rounded, the most anterior point at about the mid-height of the shell, passing below with regular curvature into the basal margin; basal margin convex throughout, but becoming straighter posteriorly; postero-basal margin broadly rounded; posterior margin subtruncate above. Valves moderately convex, the beaks at about the middle of the hinge-line and but slightly elevated above it; the umbonal ridge rounded, the post-umbonal slope gentle. Indentation of both an anterior and a posterior muscular ridge present in the casts, both of them slight but the posterior one somewhat the stronger. The larger casts marked by more or less indistinct radiating costæ above the pallial impression. Hinge teeth short, arranged in an arcuate line, diverging from either

side of the beak, 20 or more in number. Surface of the valves as indicated by impressions of the exterior marked only by more or less indistinct lines of growth.

Remarks.—This seems to be a very distinct species of *Trigonarca* which is characterized by the slight elevation of the beaks above the hinge-line, and in the shell itself must have had very low cardinal areas. All the New Jersey specimens observed are in the form of internal casts.

Formation and locality.—Cliffwood clay, Cliffwood Point (185).

Geographic distribution.—New Jersey, North Carolina.

Trigonarca triquetra Conrad.

Plate XXX., Fig. 16.

1875. *Trigonarca triquetra* Con., Kerr's Rep. Geol. Surv. N. Car., App. A, p. 2, pl. 1, fig. 7.

1872. ——— ——— Con., Proc. Acad. Nat. Sci. Phil., 1872, pl. 2, fig. 5.

Description.—Shell subtriangular in outline, the dimensions of a right valve being: length, 41 mm.; height, 32 mm.; convexity of one valve, 8.5 mm. Hinge-line strongly arcuate; anterior margin broadly rounded, passing regularly into the gently convex basal margin; postero-basal margin rather sharply rounded; posterior margin obliquely truncate. The valves moderately convex, the beaks situated near the middle of the hinge-line and but slightly elevated above it; umbonal ridge rounded, the post-umbonal slope gentle below, becoming more abrupt towards the beak. Indentations of both anterior and posterior muscular ridges present in the casts, the anterior indentation very slight, posterior one much stronger, its lower end below the mid-height of the shell. Pallial impression distinct, above which the surface of the cast is marked by distinct radiating grooves and costæ. Hinge strongly arcuate, teeth short, diverging from either side of the beak, thirty or more in number. Surface of the valves, as indicated by impressions of the exterior, marked by fine, crowded, concentric lines of growth, and by indistinct, rather broad and flat radiating costæ upon the central portion of the shell.

Remarks.—In New Jersey this species has been recognized only in the Cliffwood clays, all the specimens observed being internal casts. The types of the species have not been seen, but the Cliffwood specimens have been compared with authentic examples from Snow Hill, North Carolina, in the collection of the Philadelphia Academy of Science, and there can be no doubt as to the identity of the New Jersey specimens with those from the South. This species is associated with the last, and may be distinguished from it by its larger size, its more nearly subtriangular outline, and especially by its more strongly arcuate hinge, the hinge-plate bearing the teeth extending far down along the posterior margin of the shell, and also down the anterior margin but apparently not so far as behind. This strongly arcuate hinge is apparently the most characteristic feature of the shell.

Formation and locality.—Cliffwood clay, Cliffwood Point (185).

Geographic distribution.—New Jersey, North Carolina.

Trigonarca cuneiformis Conrad.

Plate XXX., Figs. 18–20.

1869. *Trigonarca cuneiformis* Con., Am. Jour. Conch., vol. 5, p. 98, pl. 9, fig. 1.

1886. *Trigonarca cuneiformis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 88, pl. 12, figs. 17-18.

1905. *Trigonarca cuneiformis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 9.

Description.—"Shell quite small, not exceeding half an inch in extreme length in any of the examples yet observed. Trapezoidal in outline and quite ventricose. Hinge but little more than one-half the length of the shell, and the area very narrow. Beaks small, slightly incurved. Anterior end of the shell regularly rounded; posterior end elongate, produced below, the posterior margin very oblique, so as to make the postero-basal angle quite acute. Hinge-plate very narrow, marked by oblique transverse teeth, the anterior end having 10 or 12 directed inward below, and the posterior a somewhat larger number pointed

in the opposite direction. Muscular impression large, the posterior one bordered by a slightly elevated lamella on the anterior margin. Surface of the shell marked by radiating lines, strongest on the anterior end and faintest on the middle of the valve; also by concentric lines which cross them and form slight pustules at the junctions." (Whitfield.)

The dimensions of an internal cast are: length, 6 mm.; height, 3.5 mm.

Remarks.—This is a rare form and has been observed in the recent collections of the Survey only in the Woodbury clay near Matawan. The species has previously been known only from the Woodbury clay near Haddonfield, and because of the small size of the shells Whitfield has suggested that the very few specimens known might be young individuals of some larger species. The occurrence of the species near Matawan, however, with essentially the same dimensions as the original specimens, and the entire absence of any larger individuals anywhere, would seem to indicate that these specimens were adult.

Formation and locality.—Woodbury clay, near Matawan (103), near Haddonfield (183).

Geographic distribution.—New Jersey.

Genus BREVIARCA Conrad.

Breviarca saffordi (Gabb).

Plate XXX., Figs. 21–24.

1860. *Arca saffordi* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 397, pl. 68, fig. 37.

1861. *Arca Saffordi* Gabb, Synop. Moll. Cret. Form., p. 153 (97).

1864. *Arca Saffordi* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 9.

1868. *Trigonarca Saffordi* Con., Cook's Geol. N. J., p. 725.

1872. *Breviarca Saffordi* Con., Proc. Acad. Nat. Sci. Phil. (1872), p. 55, pl. 2, fig. 3.

1875. *Trigonarca (Breviarca) Saffordi* Con., Kerr's Geol. N. Car., App. A., p. 3.

1886. *Breviaraca Saffordi* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 87, pl. 12, figs. 11-12.

1905. *Arca saffordi* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 9.

Description.—"Shell rather small, ovately trapezoidal in outline, with strongly ventricose valves and large, tumid, subcentral beaks, which stand prominently above the hinge line, are incurved and approximate. Hinge line about two-thirds as long as the entire length of the valves, with a moderately high, vertically striated area, the striated portion being bounded by a plain border over which the striations do not extend. Anterior end sharply rounded and the basal line round and full. Posterior extremity oblique, extended somewhat below and rounding into the basal line. Posterior umbonal ridge rounded but quite distinct. Surface covered entirely with fine, slightly raised thread-like striæ, which are somewhat alternating in size on the postero-cardinal slope. Hinge plate moderately wide and distinctly arched on the inner margin, the line of teeth more distinctly arcuate. Teeth numerous, narrow, and diverging outward from beneath the beak, and gradually increasing in length to near the outer ones. Muscular impressions proportionally large and distinct, the posterior one having a slightly raised line on its anterior margin, but only seen in the larger specimens." (Whitfield.)

Remarks.—The specimens in the recent New Jersey collections which have been referred to this species, are all internal casts from the Woodbury clay; they vary considerably in form, some of them being about as oblique as Whitfield's illustration of *B. saffordi*, while others are almost exactly equilateral and have the aspect of a small, strongly convex *Axinea*. It seems to be impossible, however, to separate the oblique specimens from the equilateral ones, as all intermediate variations seem to exist. The species differs from *B. cuneata*, with which it is associated, in its smaller size, often by its more equilateral form, and by the less conspicuous concentric markings of the shell.

Formation and locality.—Woodbury clay, Lorillard (102), near Matawan (103), near Haddonfield (168).

Geographic distribution.—New Jersey, Tennessee.

Breviarca cuneata (Gabb).

Plate XXX., Fig. 27.

1876. *Trigonarca cuneata* Gabb, Proc. Acad. Nat. Sci. Phil., 1876, p. 316.

1905. *Trigonarca cuneata* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 9.

Description.—Shell oblique, subtriangular in outline, the dimensions of a nearly complete internal cast of a left valve being: length 23 mm., height 18.5 mm., convexity 7.5 mm. Anterior margin rounding from the anterior extremity of the hinge-line into the basal margin, which is gently convex in the central portion, curving upward more abruptly in front and behind; postero-basal extremity rather sharply rounded; posterior margin obliquely truncate. Valves strongly convex or somewhat ventricose; the beaks, in the casts, rather large and somewhat incurved, elevated above the hinge-line, situated in front of the middle of the shell at about the middle of the hinge-line; umbonal ridge rather sharply rounded, the postero-dorsal slope abrupt; in front of the umbonal ridge the surface is nearly flat or gently convex for some distance, and then curves rather abruptly to the anterior margin. Hinge-plate with about 12 or 15 teeth on either side of the beak. Surface marked by rather strong concentric lines of growth and by fainter radiating striæ.

Remarks.—This species occurs in the form of internal casts in the Woodbury clay at Lorillard, and can be distinguished from *B. saffordi,* with which it is associated, by its larger size and by the more conspicuous concentric markings of the shell, shown on impressions of the exterior. These New Jersey examples have been compared with the type and oher authentic specimens from the South, and there seems to be no doubt as to the identity of the species, although their condition of preservation is very different.

Formation and locality.—Merchantville clay-marl, near Matawan (101[1]), near Jamesburg (141); Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey, Georgia.

Family ARCIDAE.

Genus ARCA Lamark.

Arca uniopsis Conrad.

Plate XXXIV., Figs. 6–8.

1853. *Arca uniopsis* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 275, pl. 24, fig. 17.
1861. *Arca uniopsis* Gabb, Synop. Moll. Cret. Form., p. 154 (98).
1864. *Arca uniopsis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 9.
1868. *Arca ? uniopsis* Con., Cook's Geol. N. J., p. 725.
1886. *Cibota uniopsis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 92, pl. 11, figs. 32-33.
1905. *Arca uniopsis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 9.

Description.—"Shell rather above a medium size, transversely elongate, and trapezoidal or subrhomboidal in outline, with moderately convex valves, which are broadly sulcated in the middle, particularly on the right valve, and only moderately elevated beaks, situated at about the anterior third of the length, and which in the casts appear to have been scarcely enrolled and moderately distant from each other. Hinge-line not quite as long as the body of the shell, in the cast showing characters of a rather low area; anterior end obliquely rounded, receding below; basal line broadly sinuate and the posterior end obliquely truncate, longest below the center." (Whitfield.)

The surface marked by radiating costæ which are not present upon the internal casts. Muscular scars faintly impressed.

The dimensions of an internal cast illustrated by Whitfield are: length 50 mm., height 24 mm., thickness 17 mm.

Remarks.—This species resembles *Arca rostellata*, and like that species it is rare and usually occurs in the form of internal casts. The casts of this species may be distinguished, however, by their proportionately greater height, the more central position

of the beaks, and the more conspicuous sinus, especially in the right valve, extending from the beaks obliquely to the ventral margin. The casts of this species are also nearly destitute of any indications of the radiating costæ of the shell, while in *Arca rostellata* the impressions of the plications are clearly seen.

Formation and locality.—Merchantville clay-marl?, Burlington County (Coll. Phil. Acad. Sci.); Navesink marl, Atlantic Highlands (108), Crosswicks Creek (149, 195).

Geographic distribution.—New Jersey.

Arca rostellata Morton.

Plate XXXIV., Figs. 4–5.

1834. *Arca rostellata* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 64, pl. 3, fig. 11.
1861. *Cibota rostellata* Gabb, Synop. Moll. Cret. Form., p. 165 (109).
1864. *Cibota rostellata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 9.
1868. *Arca rostellata* Con., Cook's Geol. N. J., p. 725.
1886. *Cibota rostellata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 91, pl. 11, figs. 34-36.
1905. *Arca rostellata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 9.

Descripion.—"Shell trapezoidal and very oblique, the length being about twice and a half the height, with subparallel cardinal and basal margins, posterior end very obliquely prolonged below, and the anterior end rather rapidly rounding backward from near the hinge-line to its junction with the base. Basal margin very perceptibly sinuate nearly opposite the beaks and apparently very slightly gaping. Valves moderately inflated, most ventricose on the umbones just anterior to the sulcus, which crosses them from the beak to the sinus of the base, and then rapidly declining to the anterior extremity, but sloping quite gradually on the posterior side. Beaks moderately large, somewhat projecting above the hinge and slightly incurved; situated at about

the anterior third of the entire length of the valves. Cardinal area moderate in size and extending about two-thirds of the length. Teeth unknown. Surface as indicated on internal casts marked by radiating ribs, pretty fine and numerous on the anterior end and in the mesial sulcus, becoming much coarser posteriorly, and showing a slight tendency to alternation in size between the sulcus and posterior umbonal angle, and on the cardinal slope a tendency to bifurcation in some cases." (Whitfield.)

The dimensions of a perfect internal cast are: length, 38 mm.; height, 18.5 mm.; thickness, 13 mm.

Remarks.—No examples of this species have been met with in the recent collections of the Survey. The most perfect individual illustrated by Whitfield has the general outline of Morton's type from Alabama, but is not so conspicuously marked by radiating costæ, and has not so broad a byssal gap in the ventral margin.

Formation and locality.—Navesink marl, Holmdel (Coll. N. J. Geol. Survey).

Geographic distribution.—New Jersey.

Arca obesa (Whitfield).

Plate XXXIV., Fig. 9.

1886. *Cibota obesa* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 93, pl. 11, figs. 30-31.

1905. *Cibota obesa* Johns., Proc. Acad. Nat. Sci. Phil., (1905), p. 9.

Description.—"Shell small, with full and very ventricose valves, large tumid beaks situated opposite the anterior third of the length, slightly enrolled, and distant from each other as shown on the internal cast. Form of the outline trapezoidal, the length of the cast nearly twice the height, exclusive of the projection of the beaks; anterior end vertically rounded; posterior obliquely truncate; extremity obtusely pointed; basal line full, but constricted just anterior to the middle by the very marked but short and broad byssal opening; area two-thirds the length of the valve and moderately wide. On the casts the muscular imprints are very distinctly marked and of fair size, no muscular ridge; the

outer margin indicating a strong and abrupt thickening of the valves with a crenulated border; radiating lines indicating moderately fine striæ show on nearly all parts of the cast, but strongest on the postero-basal section." (Whitfield.)

The dimensions of Whitfield's type of this species are: length, 25.5 mm.; height, 15.5 mm.; thickness, 13.5 mm.

Remarks.—This species is not uncommon at some localities in the Merchantville clay, but it is usually poorly preserved. In fact, three of the species referred to the genus *Cibota* by Whitfield, but here transferred to *Arca, A. rostella, A. uniopsis* and *A. obesa* are more or less alike in many respects, and in their condition of preservation in the New Jersey collections it is not possible to determine with certainty whether they may not be different manifestations of a common species. For the present, however, the three species may be considered as distinct, although there may be some doubt, in many cases, as to the correct identification of the imperfect specimens from the New Jersey beds.

Formation and locality.—Merchantville clay-marl, Lenola (163).

Geographic distribution.—New Jersey.

Arca quindecemradiata Gabb.

Plate XXXIV., Figs. 2–3.

1860. *Arca quindecemradiata* Gabb, Proc. Acad. Nat. Sci. Phil., 1860, p. 95, pl. 2, fig. 2.

1860. *Cibota multiradiata* Gabb, Proc. Acad. Nat. Sci. Phil., 1860, p. 95, pl. 2, fig. 1.

1861. *Arca quindecemradiata* Gabb, Synop. Moll. Cret. Form., p. 153 (91).

1861. *Cibota multiradiata* Gabb, Synop. Moll. Cret. Form., p. 165 (109).

1861. *Arca altirostris* Gabb, Proc. Acad. Nat. Sci. Phil., 1861, p. 325.

1861. *Cucullæa transversa* Gabb, Proc. Acad. Nat. Sci. Phil., 1861, p. 326.

1864. *Arca altirostrata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 8.

1864. *Arca quindecemradiata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 9.
1864. *Cucullæa transversalis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 8.
1864. *Cibota multiradiata* Meek, Check List Inv. Foss. N. A., Cret. and Jur. p. 9.
1868. *Idonearca quindecemradiata* Con., Cook's Geol. N. J., p. 376, figure.
1868. *Arca altirostris* Con., Cook's Geol. N. J., p. 725.
1868. *Idonearca transversa* Con., Cook's Geol. N. J., p. 725.
1868. *Arca ? quindecemradiata* Con., Cook's Geol. N. J., p. 725.
1886. *Arca altirostris* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 82, pl. 12, figs. 22-23.
1886. *Trigonarca transversa* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 89, pl. 12, figs. 13-16.
1886. *Cibota multiradiata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 94, pl. 11, figs. 21-22.
1886. *Arca quindecemradiata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 208, pl. 27, figs. 10-13.
1905. *Arca altirostris* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 9.
1905. *Arca quindecemradiata* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 9.
1905. *Cucullæa gabbi* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 8.

Description.—Shell usually somewhat below medium size, the dimensions of a rather small but nearly perfect internal cast being: length, 22.5 mm.; thickness, 23.5 mm.; height, 22.5 mm.; length of hinge-line, 21.5 mm.; very inequilateral, the valves ventricose, with prominent, projecting, distant and slightly incurved beaks in the internal casts, situated in front of the mid-length of the shell and a little in front of the mid-length of the hinge-line. Anterior margin rounding rapidly backward from the anterior extremity of the hinge-line and passing without interruption into the broadly rounded basal margin; postero-basal extremity sharply rounded or subangular, situated below the mid-height of the shell; posterior margin obliquely truncate, meeting

the hinge-line in an obtuse angle. On the internal casts the free margins of the shell are more or less keeled, and the muscular impressions are of moderate size and rather clearly marked. Surface of the casts marked by rather coarse ribs which become more and more obsolete as they approach the umbo.

Remarks.—This species rarely preserves any portion of the shell substance, usually being in the form of internal casts. Several similar forms have apparently been described as distinct, which should in all probability be included in one species, a decision arrived at after a careful study of the types of all the forms. The first name applied to any of the forms was *Arca quindecemradiata,* and fortunately, too, the original specimen to which this name was applied represents the most typical form of the species. The type of *Cibota multiradiata* Gabb, is apparently a young individual, with no characters by which it can be separated specifically from *A. quindecemradiata;* the horizon and locality given for this specimen is "Green marl, Mullica Hill, N. J.," but the lithologic character of the specimen would indicate that it was not collected from the Navesink horizon at that locality, but from one of the higher beds. The type specimen of *Arca altirostris* Gabb, is labeled "Crosswicks N. J.," which is rather indefinite since specimens which are apparently from various horizons and localities along Crosswicks Creek are so labeled in the old collections, an entire section of the Cretaceous strata being exposed along this stream. The specimen is a small internal cast and the absence of the radiating ribs which are present upon the typical *Arca quindecemradiata,* is doubtless due to the youth of the specimen and its condition of preservation. The type specimen of *Cucullaea transversa* Gabb is said to be "probably from Arneytown, N. J.," which would indicate the Navesink horizon, but the exact locality is left in doubt. Whitfield was mistaken in his identification of the type of this species, but since the publication of his monograph, the type has been found in the collection of the Philadelphia Academy of Science, and an examination of it shows it to be nothing more than an exceptionally large individual of *Arca quindecemradiata.* In 1905 Johnson proposed to substitute the name *Cucullaea gabbi* for *C. transversa* Gabb, because of the prior use of that name by Rogers in 1839.

All the examples of *Arca quindecemradiata* in both the recent collections of the Survey and in the older collections, whose horizon is definitely known, are from either the Hornerstown marl or the Vincentown limesand, and it can be stated with almost absolute certainty that the species is limited to these horizons, although the records with some of the older specimens would seem to indicate that it may possibly have been found rarely in the Navesink.

Formation and locality.—Vincentown limesand, near Hurffville (171).

Geographic distribution.—New Jersey.

Genus NEMOARCA Conrad.

Nemoarca cretacea Conrad.

Plate XXX., Figs. 25–26.

1869. *Nemoarca cretacea* Con., Am. Jour. Conch., vol. 5, p. 97, pl. 9, fig. 21.

1886. *Nemoarca cretacea* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 86, pl. 12, figs. 8-10.

1905. *Nemoarca cretacea* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 9.

Description.—"Shell small, seldom attaining more than half an inch in extreme length, trapezoidal in form, the transverse diameter being nearly once and a half the height. Valves very ventricose, with large, strongly inflated, prominent beaks, situated nearly opposite the middle of the length. Hinge-line straight and low; area narrow, the length a little less than the greatest length of the body of the shell. Hinge-plate narrow, marked by about 12 short, oblique teeth which diverge from the center on each side, and two or three transverse teeth nearly parallel to the hinge-line at the posterior end. Muscular imprints too faint to be observed on well-preserved casts of the interior. No internal rib bordering the posterior scar. Surface marked by from four to six fine radiating ribs on the posterior slope, and 24 to 26 on the body of the shell and anterior end. Strongest on the posterior part of the body of the shell and gradually decreasing in size

anteriorly. On some individuals one or more of the ribs on the posterior slope appear to be divided, while all are strongly elevated and rather sharp with narrow interspaces. On the matrix there are remains of distinct elevated concentric lines at regular distances crossing the radiating ribs." (Whitfield.)

The dimensions of a large internal cast of a right valve are: length, 11.5 mm.; height, 9.5 mm.; length of hinge-line, 8.5 mm.; convexity, 4.5 mm.

Remarks.—This species generally occurs in the form of internal casts, in which condition the umbo appears to be more prominent than when the shell itself is preserved. The impressions of the exterior show that the surface of the shell was covered with strong, close, concentric lines in addition to the radiating markings, and in one of the largest individuals observed the number of radiating costæ is seen to be about 40.

Formation and locality.—Merchantville clay-marl, near Matawan (101[2]), Lorillard (102[1]), near Jamesburg (141), Lenola (163); Woodbury clay, Lorillard (102), near Matawan (103), Crosswicks (168), near Haddonfield (165, 183); Wenonah sand, near Marlboro (130[1]); Red Bank sand, near Middletown (112).

Geographic distribution.—New Jersey.

Genus AXINEA Poli.

Axinea subaustralis (d'Orbigny).

Plate XXXV., Figs. 1–8.

1834. *Pectunculus australis* Morton, Synop. Org. Rem. Cret. Gr. U. S., p. 64. (Not *P. australis* Quoy 1833.)
1850. *Pectunculus subaustralis* D'Orb., Prod. de Pal., vol. 2, p. 243, No. 667.
1861. *Axinaea subaustralis* Gabb, Synop. Moll. Cret. Form., p. 159 (103).
1861. *Axinæa subaustralis* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 365.
1864. *Axinæa subaustralis* Meek, Check List Inv. Foss N. A., Cret. and Jur., p. 8.
1868. *Axinæa subaustralis* Con., Cook's Geol. N. J., p. 725.

1869. *Axinea mortoni* Con., Am. Jour. Conch., vol. 5, p. 44, pl. 1, fig. 14.

1876. *Axinæa subaustralis* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 317.

1886. *Axinea Mortoni* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 99, pl. 11, figs. 23-25.

1886. *Axinea alta* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 101, pl. 11, figs. 26-29.

1905. *Pectunculus australis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 10.

Description.—Shell subcircular in outline, varying in size from 15 mm. to 40 mm. in diameter, the convexity of each valve being from one-fourth to three-tenths the diameter; very slightly oblique, the beaks central in position. The internal casts compressed about the free margin especially in adult shells, the margin strongly crenulate when well preserved. The beaks strongly elevated and pointed, their lateral slopes meeting in an angle varying several degrees either way from 90°; the impression of the hinge-plate broad and arcuate, with 9 or 10 strong teeth on each side of the beak, directed at nearly right angles to the inner margin of the hinge-plate, and with several smaller teeth in the middle beneath the beak. Anterior and posterior muscular impressions well defined, especially in the larger specimens. The shell substance thick, marked externally with more or less irregular, concentric lines of growth, and by regular radiating costæ which are more or less interrupted by the concentric lines upon partially exfoliated individuals. The beaks approximate and the cardinal areas small with divergent furrows.

Remarks.—This is the common species of *Axinea* in the New Jersey Cretaceous faunas and includes both forms, *A. mortoni* and *A. alta,* recognized by Whitfield. All of Whitfield's specimens were from the Navesink marl, and a careful study of the ones he used along with many others in the recent Survey collections, shows them all to be one species. The two forms are connected by all intermediate variations, those called *A. alta* being only the larger individuals. In the Merchantville clay the

species often occurs in great abundance, but usually, after the solution of the shells in this formation, the soft material in which they were imbedded has been compressed, bringing the impression of the exterior and the surface of the internal casts into contact, more or less modifying the characters of both. Occasionally, however, the species has been preserved in harder nodules or harder beds in this formation, in such a manner that the casts have essentially the same characteristics as in the Navesink marl. The Merchantville specimens have never been observed to attain so large a size as the species sometimes reaches in the Navesink. There seems to be no valid reason for recognizing *A. mortoni* Con., as distinct from *A. australis* Mort., so that the species has here been referred to *A. subaustralis* D'Orb., a name proposed as a substitute for Morton's *A. australis* which was preoccupied. The species differs from *A. hamula* especially in the less convexity of the valves.

Formation and locality.—Merchantville clay-marl, near Matawan (101, 100[4]), near Jamesburg (139, 140, 141), Lenola (163), Merchantville (162); Navesink marl, near Crawfords Corner (126[7]), near Walnford (147[4], 148[2], 149, 195), near Jacobstown (150), near Mount Laurel (166); Tinton beds, Tinton Falls (110), Beers Hill cut, south of Keyport (129[5], 129[7], 129[9]), near Freehold (132).

Geographic distribution.—New Jersey, Alabama, Mississippi, Texas.

Axinea microdentus n. sp.

Plate XXXV., Figs. 10–11.

Description.—Shell subcircular, attaining a length and breadth of 21.5 mm. each in the largest specimen observed, the convexity of each valve from one-fourth to three-tenths the diameter. The internal casts somewhat compressed about the free margins, the margin very faintly or not at all crenate. Beaks moderately elevated, pointed, and slightly oblique, their lateral slopes meeting at an agle of about 90°; the impression of the hinge-plate of moderate width, with 11 or 12 teeth on each side of the beak, with several less distinct ones in the middle beneath the beak;

the individual teeth on each side are slightly oblique to the inner margin of the hinge-plate, the anterior and posterior rows are nearly straight or slightly convex, meeting beneath the beak in a rounded angle. Both muscular impressions moderately developed. The external surface of the shell, as indicated by impressions, is marked by fine, regular, radiating costæ, and by more or less irregular concentric lines of growth. The beaks are approximate and the cardinal areas small.

Remarks.—This species is very similar to *A. subaustralis,* but may be distinguished from it by its much smaller teeth which are arranged in a broadly ∧-shaped hinge with the angle under the beak rounded, instead of in a broadly arcuate line. Another distinction is found in the almost or wholly obsolete crenulations upon the interior of the free margins of the valves.

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey.

Axinea compressa n. sp.

Plate XXXV., Fig. 9.

Description.—Shell subcircular, the valves compressed, oblique, the height of the type specimen 23 mm., its length about 25 mm., its convexity 4 mm. The anterior margin from the beak to the middle of the basal margin forms nearly a semicircle, the posterior margin is obliquely subtruncate above from the beak nearly to the middle of the shell, below which point it rounds into the basal margin. In the internal casts the free margin is strongly crenate; the beaks pointed, the lateral slopes meeting in an angle of about 90°; impression of the hinge-plate rather broad, with 10 or more rather strong teeth visible on each side of the beak, the teeth are placed a little obliquely to the inner margin of the hinge-plate, the anterior row is slightly arcuate, the posterior row nearly straight. The posterior muscular impression is slightly defined, the anterior one scarcely recognizable. The external surface of the shell, as indicated by an impression, is marked only with concentric lines of growth.

Remarks.—This species somewhat resembles *A. subaustralis,* but besides being more oblique, it is a much more compressed shell. The type consists of the nearly perfect cast of the interior of a right valve with the accompanying impression of the exterior. This specimen shows no sign of radiating costæ upon the exterior, but associated with it is a very imperfect and much crushed impression of another individual, possibly belonging to the same species, which preserves the impressions of fine radiating costæ upon at least a portion of the shell surface, but these costæ are much finer than those which have been observed upon *A. subaustralis.*

Formation and locality.—Red Bank sand, near Middletown (112).

Geographic distribution.—New Jersey.

Axinea congesta (Conrad).

Plate XXXV., Figs. 12–19.

1875. *Trigonarca* (*Breviarca*) *congesta* Con., Kerr's Geol. N. Car., App. A, p. 3, pl. 1, fig. 2.

Description.—Shell small, equilateral or very slightly oblique, longer than high, subelliptical in outline; the dimensions of the largest specimen observed are: length, 12 mm.; height, 10.5 mm.; convexity, 3 mm. Valves moderately and evenly convex; hinge-line nearly straight, arched downward on each side, the cardinal extremities rounding into the general subelliptical outline of the entire shell; internal casts scarcely compressed about the free margins, not crenate; the beak central, prominent, rounded, a little produced beyond the hinge-line in the casts, impressions of the exterior show a small vertically striated cardinal area; impression of the hinge-plate rather broad, with 7 or 8 larger teeth at each end set obliquely to the inner margin of the hinge-plate, the median portion beneath the beak with smaller, nearly vertical teeth; the central half of the entire row of teeth is straight, the outer one-fourth on each side being slightly arched downward. Surface of the casts smooth, the muscular impressions inconspicuous. External surface, as indicated by impressions, marked by narrow radiating costæ, narrower than the interspaces, and by more or less inconspicuous concentric lines of growth.

Remarks.—This species can be recognized by its smaller size, its more elliptical form and its straighter hinge-line than any other members of the genus in New Jersey.

Formation and locality.—Cliffwood clay, Cliffwood Point (105, 185), near Matawan (107, 189); Woodbury clay, Lorillard (102), near Matawan (103); Wenonah sand, near Marlboro (130[1]).

Geographic distribution.—New Jersey, North Carolina.

Super-family PTERIACEA.

Family PINNIDAE.

Genus PINNA Linneus.

Pinna laqueata Conrad.

Plate XXXVI., Fig. 1; Plate XXXVII., Fig. 1.

1858. *Pinna laqueata* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 328.
1861. *Pinna laqueata* Gabb, Synop. Moll. Cret. Form., p. 222 (166).
1864. *Pinna laqueata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 9.
1868. *Pinna laqueata* Con., Cook's Geol. N. J., p. 725.
1886. *Pinna laqueata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 81, pl. 16, figs. 1-2.
1905. *Pinna laqueata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 10.

Description.—"Shell of moderate size, very rapidly expanding from the apex and ventricose, giving a subquadrangular section. Surface marked by from 9 to 11 strong, simple, radiating ribs on the dorsal portion, which are broad and rounded on the top and separated by very broad concave interspaces. The lower or basal portion is marked by very strong concentric striæ parallel to the margin, so very irregular as to often form strong undulations of the surface. Line of division between the upper and lower sections of the valves very strongly marked on the cast, often presenting the appearance of a distinct suture. Posterior margin

of the shell apparently double, being deeply emarginate or lobed at the line of division between the upper and lower portions of the valve. The margin of the upper division is obliquely truncate, receding from below to the hinge-line, and strongly curved inward at the central emargination. Lower section also strongly lobed and somewhat rounded." (Whitfield.)

Remarks. The specimens of this shell have only been observed in a fragmentary condition so that the full dimensions of the species cannot be determined from actual observation. The largest specimen illustrated by Whitfield is 80 mm. in maximum height, and its length when complete must have been 250 mm. or more. In the younger individuals of the species, as well as in the older portion of full grown specimens, the sharp differentiation between the upper and lower portions of the shell is much less marked than in the mature portion of the shell, the cross-section of the shell near the beak sometimes being nearly circular. The species is most characteristic of the Merchantville clay, but a few fragmentary individuals, which seem to belong to the same species, have been recognized from the Navesink marl.

Formation and locality.—Merchantville clay-marl, Lenola (163), near Jamesburg (140), Burlington (Whitfield); Woodbury clay, near Haddonfield (183); Navesink marl, near Crawfords Corner (126[7]), near Walnford (148[2]), near Jacobstown (150).

Geographic distribution.—New Jersey, Mississippi, Arkansas.

Pinna rostriformis Morton.

Plate XXXVII., Figs. 2–3.

1834. *Pinna* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 63.
1841. *Pinna rostriformis* Mort., Proc. Acad. Nat. Sci. Phil., vol. 1, p. 132.
1842. *Pinna rostriformis* Mort. Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 8, p. 214, pl. 10, fig. 5.
1861. *Pinna rostriformis* Gabb, Synop. Moll. Cret. Form., p. 223 (166).
1864. *Pinna rostriformis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 9.

1868. *Pinna rostriformis* Con., Cook's Geol. N. J., p. 725.
1886. *Pinna rostriformis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 198, pl. 16, figs. 3-4.
1905. *Pinna rostriformis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 10.

Description.—When complete the shell attains a length of 80 mm. or more, with a height of 32 mm. or more. Shell elongate triangular in form, with an attenuated, pointed anterior extremity; the beak anterior. Hinge-line straight, nearly equaling the total length of the shell; basal margin broadly concave in the anterior third of its length, becoming gently convex posteriorly; posterior margin broadly rounded, the dorsal portion extending farther forward than the ventral. Valves ventricose, subangular along the median line of the shell. The upper two-thirds of the surface marked by rather strong radiating costæ; the entire surface marked by concentric lines of growth, and by undulations which become stronger upon the lower non-radiate portion of the shell.

Remarks.—This species has only been observed in a more or less fragmentary condition. It resembles *P. laqueata,* but is more slender in front, with the anterior portion of the ventral margin decidedly concave.

Formation and locality.—Vincentown limesand, Cookstown (151), Timber Creek (Whitfield).

Geographic distribution.—New Jersey.

Family PERNIDAE.

Genus GERVILLIOPSIS Whitfield.

Gervilliopsis ensiformis (Conrad).

Plate XXXVII., Figs. 4-5; Plate XXXVIII., Figs. 1-3.

1858. *Gervillia ensiformis* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 328, pl. 34, fig. 10.
1861. *Gervillia ensiformis* Gabb, Synop. Moll. Cret. Form., p. 180 (114).
1864. *Gervillia ensiformis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 9.

1868. *Gervillia ensiformis* Con., Cook's Geol. N. J., p. 726.
1886. *Gervilliopsis ensiformis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 73, pl. 15, figs. 8-11, pl. 16, fig. 5.
1887. *Dalliconcha ensiformis* White, Proc. Acad. Nat. Sci. Phil., 1887, p. 35, pl. 2, fig. 6.
1905. *Gervilliopsis ensiformis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 10.

Description.—"Shell of moderately large size and thickened, falciform, very oblique; the body of the shell finally becoming parallel to the hinge or even slightly recurved, narrowing posteriorly and flattened on the surface. Hinge-line straight, short, not more than one-fourth the length of the shell in grown individuals; posterior wing only moderately elevated, and the posterior margin rapidly sloping backward from its extremity to the body of the shell, anterior wing very slight, the anterior end of the shell being squarely truncate at right angles to the hinge. Beak of the shell small and terminal, elevated above the wing and continuing in a ridge to the surface of the valve. Greatest width of the shell opposite the posterior extremity of the hinge. Surface of the shell lamellose, and marked by numerous concentric varices of growth, and on the basal portion of the right valve indications of fine radiating lines occur. Hinge area moderately wide, marked by several transverse ligamental pits, arranged at a little more than one-fourth of an inch apart, and also by numerous oblique corrugations. Muscular imprints large and obliquely situated. Substance of the shell highly nacreous throughout and iridescent." (Whitfield).

The dimensions of a large, nearly perfect individual illustrated by Whitfield, are: extreme length, 190 mm.; length of hinge-line 48 mm.; height at posterior extremity of hinge-line, 44 mm.; greatest width of body of shell, 35 mm.

Remarks.—Whitfield states that the only specimens of this species from New Jersey which have come under his observation are from Woodbury. These Woodbury specimens preserve the shell in most cases, in an excellent state of preservation, but none

of them have been secured in the recent collections of the Survey. The locality from which it is believed that these specimens were collected, is in the Marshalltown clay-marl and is no longer accessible.

More or less imperfect specimens of the internal casts of a member of this genus, occur rarely in the Merchantville and Navesink formations, and more commonly in the Red Bank. These specimens are difficult to determine with entire satisfaction, and it is possible that they should be referred to *G. minima* Whitf. In size they have not been observed to attain the large dimensions of the complete specimen of *G. ensiformis* illustrated by Whitfield, the maximum length probably being 70 mm. to 80 mm. *G. minima* was established upon a single individual about 26 mm. in length, said to differ from *G. ensiformis* in being much more ventricose, and since none of these casts referred to seem to possess this strong ventricosity, they have all been referred to *G. ensiformis*. It is altogether possible that the type of *G. minima* is only a variation of the more common form.

Formation and locality.—Merchantville clay-marl, Lenola (163); Woodbury clay, near Haddonfield (183); Marshalltown clay-marl, near Woodbury (Whitfield); Wenonah sand, near Marlboro (130); Navesink marl, Atlantic Highlands (108), Mullica Hill (169[2]), near Freehold (133); Red Bank sand, Red Bank (116).

Geographic distribution.—New Jersey, Alabama, Mississippi.

Gervilliopsis minima Whitfield.

1886. *Gervilliopsis minima* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 74, pl. 15, fig. 7.

Description.—"Shell small, the only specimen observed, a cast, measuring only a trifle over one inch in length, and less than three-eighths of an inch in its greatest width. Shell elongate-elliptical, extremely oblique, slightly curved, and the valves very ventricose. The beaks, as shown on the cast, have been pointed, the area wide, and the anterior hiatus has been proportionally large and distinct. The muscular scars are very distinct and well marked." (Whitfield).

Remarks.—This species was described as being "a miniature of *G. ensiformis,* except in its greater ventricosity." The type specimen seems to have been lost or destroyed, as it can be found neither in the collection at Trenton nor at Rutgers College. Specimens having these characters, however, are not uncommon in the Ripley formation of Mississippi, and the species is undoubtedly a good one. The smaller examples from New Jersey in the recent collections are none of them so ventricose as the southern specimens which have been observed, and seem to be more properly but small individuals of *G. ensiformis,* and have been so identified.

Formation and locality.—Navesink marl, Freehold (Whitfield).

Geographic distribution.—New Jersey, Mississippi.

Genus INOCERAMUS Sowerby.

Inoceramus proximus Tuomey.

Plate XL., Figs. 1–6; Plate XLI., Fig. 1.

1854. *Inoceramus proximus* Tuom., Proc. Acad. Nat. Sci. Phil., vol. 7, p. 171.
1860. *Inoceramus Mortoni* M. & H., Proc. Acad. Nat. Sci. Phil., 1860, p. 428.
1861. *Inoceramus proximus* Gabb, Synop. Moll. Cret. Form., p. 185 (129).
1864. *Inoceramus proximus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 10.
1876. *Inoceramus proximus* ? Meek, Rep. Inv. Cret. and Ter. Foss. Up. Mo., p. 53, pl. 12, figs. 7 a-b.
1886. *Inoceramus Sagensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 76, pl. 14, fig. 15, pl. 15, figs. 1-2.

Description.—Shell in large examples attaining a height of 100 mm. or more, and a length of 120 mm. or more. The valves subovate in outline, moderately convex, the hinge-line about two-thirds the length of the shell, the beak but little ele-

vated above the hinge-line. The anterior margin sloping forward from the beak and rounding gradually into the broadly rounded basal margin, posterior margin broadly rounded and meeting the hinge-line in an obtuse angle. Surface of the shell marked by more or less rounded or subangular, concentric undulations, which are often somewhat irregular in the strength of their development and in their distances apart. In addition to the undulations the surface of the shell is marked by fine concentric striæ separated by intervals of 1 mm. or less.

Remarks.—This species is the common member of the genus in the Merchantville clay-marl, and includes, without doubt, the two specimens illustrated by Whitfield as *I. sagensis.* In Owen's original description of *I. sagensis,* which occurs typically in the western faunas, it is distinctly stated that the shell is not marked by concentric striations, while the New Jersey examples always have these lines when the surface markings can be seen; furthermore the valves of the eastern form are usually less strongly convex than those of the western specimens. The concentric striæ are usually not recognizable upon the internal casts, although they may sometimes be detected, but they can almost always be seen upon the impressions of the outside of the shells. These striæ in most cases seem to be slightly raised lines, but in one specimen from the Cliffwood clay they are apparently impressed. One large example from Lenola with a length of 135 mm., has a broad, smooth area without undulations around the free margins of the shell, a character which is sometimes seen in other species of the genus and which doubtless represents a senile stage of growth. Among the various specimens examined, there is considerable variation in the width of the spaces between the concentric undulations of the shell, and in some specimens these undulations bifurcate anteriorly and more rarely posteriorly.

Formation and locality.—Cliffwood clay, Cliffwood Point (105), near Matawan (189); Merchantville clay-marl, near Matawan (100^3, 100^4, 101), near Jamesburg (139, 141), Lenola (163); Marshalltown clay-marl, near Swedesboro (177).

Geographic distribution.—New Jersey, Mississippi, Arkansas, Texas.

Inoceramus quadrans Whitfield.

Plate XXXIX., Fig. 1.

1886. *Inoceramus Sagensis,* var. *quadrans* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 79, pl. 14, fig. 16.

1905. *Inoceramus sagensis* var. *quadrans* Johns., Proc. Acad. Nat. Sci., Phil. (1905), p. 10.

Description.—Shell moderately convex, subquadrangular, broadly subovate, the dorsal and ventral margins subparallel or slightly diverging posteriorly. The beak large and prominent, produced beyond the hinge-line. Anterior margin truncate to a point below the middle, and forming with the hinge-line nearly a right angle; below the middle it rounds into the nearly straight basal margin, which in turn posteriorly passes with a regular curve into the posterior margin which is rounded below and obliquely subtruncate above, meeting the posterior extremity of the hinge-line in an oblique angle. The surface is marked by somewhat irregular, subangular undulations which are more crowded and less distinct towards the umbonal region, those on the outer portion of the shell being rather widely separated. "The middle of the cast for about two-thirds the width is marked by strong, rather deep pits, connected by shallow furrows, showing that the interior of the shell was covered with strong pearl-like protuberances." (Whitfield).

The dimensions of the type specimen are: length, 102 mm.; height from hinge-line to basal margin, 78 mm.

Remarks.—Whitfield described this species as a variety of *I. sagensis,* but it is so distinctly different from typical members of that species that it seems to be well worthy of recognition as of full specific rank. Furthermore, the species of which he considered it a variety is not the true *I. sagensis,* but is here referred to *I. proximus.* The species is especially characterized by its truncate anterior margin and subquadrangular form. It has not been met with in the recent collections.

Formation and locality.—Merchantville clay-marl (?), Burlington (Whitfield).

Geographic distribution.—New Jersey.

Inoceramus confertim-annulatus Rœmer.

Plate XXXIX., Figs. 2–5.

1849. *Inoceramus confertim-annulatus* Roem., Texas, p. 402.
1852. *Inoceramus confertim-annulatus* Roem., Kreid. von Texas, p. 59, tab. 7, fig. 1.
1857. *Inoceramus confertim-annulatus* Con., Rep. U. S. and Mex. Bound. Surv. vol. 1, pt. 2, p. 151, pl. 5, fig. 5.
1886. *Inoceramus Barabini* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 75, pl. 15, figs. 3-5. (Not *I. barabini* Morton.)

Description.—"Shell of only moderate size, transversely ovate or elliptical, with moderately to prominently convex valves. Beaks large, only slightly projecting beyond the line of the hinge, and situated near the anterior end. Hinge-line two-thirds as long as the shell, and rapidly rounding at the posterior extremity into the posterior margin, which is more broadly rounded than the anterior extremity. Basal line gently and somewhat gradually arcuate, but more rapidly curving upward near the anterior part. Surface of the shell marked by regular concentric, rounded undulations parallel to the margin of the valve, and separated by concave interspaces. Near the outer limits of the valve the undulations become more irregular, as if taking on old-age characters." (Whitfield.)

The dimensions of the two specimens illustrated by Whitfield are: length, 54 mm. and 50 mm.; height from hinge-line to ventral margin, 39 mm. and 36 mm.; convexity of the larger specimen, 14.5 mm.

Remarks.—These shells were identified as *I. barabini* by Whitfield, but they seem to differ essentially from that species as interpreted by Meek, and his interpretation, based upon a careful study of Morton's imperfect type specimens, seems to be entirely correct. The most conspicuous feature of the true *I. barabini* is the much greater height of the shell posteriorly than in front, while in the New Jersey specimens the height of the shell beneath the beak is nearly or quite equal to that near the posterior extremity of the hinge-line. The New Jersey shells much more

closely resemble the specimen Meek has identifid as *I. proximus*, although the beaks are not quite so far forward as in Meek's illustration, but the shells are too ventricose for that species. The specimens seem to agree most closely with *I. confertim-annulatus* Roem., described from the Eagle Ford shales of Texas, and have therefore been so identified,; they resemble both of these species, however, much more closely than they do *I. barabini*. The species is apparently somewhat rare as it has been met with only rarely in the recent collections.

Formation and locality.—Navesink marl, near Holmdel (128[3]), near Freehold (133), Crosswicks Creek (147[4], 195), Mullica Hill (169[2]).

Geographic distribution.—New Jersey, Texas.

Inoceramus proobliqua Whitfield.

Plate XXXVIII., Fig. 4.

1886. *Inoceramus pro-obliqua* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 80, pl. 14, fig. 17.

Description.—"Shell somewhat below the medium size for the genus; subovate in outline, the axis of the shell being directed forward of a right angle to the hinge-line, instead of backward as is usual with nearly all shells. Hinge-line shorter than the width of the body of the shell and forming an angle of about 110° to the axis of the valve. Left valve, the only one known, extremely ventricose, with a rather small beak, which is but little elevated above the line of the hinge, and situated in advance of the anterior margin of the valve. Height of the valve a little greater than its extreme width or length. Surface of the cast marked by numerous, regularly increasing concentric undulations, which are moderately sharp on the crests and the interspaces broadly concave. There are also indications of radiating lines along the middle of the valve, as in many species of the genus." (Whitfield.)

The dimensions of the type specimen are: length, 42 mm.; height, 45 mm.

Remarks.—This species of *Inoceramus* is remarkable in that the line of obliquity is directed forward in passing from the beak to the basal margin instead of backward as is usually the case. The species was established upon a single individual, and it has not been met with in any of the recent collections.

Formation and locality.—Navesink marl, Holmdel (Whitefield).

Geographic distribution.—New Jersey.

Family PTERIIDAE.

Genus PTERIA Scopoli.

Pteria petrosa (Conrad).

Plate XLII., Figs. 1–2.

1853. *Avicula petrosa* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 2, p. 274, pl. 24, fig. 15.
1854. *Avicula linguæformis* Evans & Shumard, Proc. Acad. Nat. Sci. Phil. 1854), p. 163.
1859. *Avicula linguæformis* Meek, Hind's Rep. Assin. and Saskat. Expl. Exped., p. 183, pl. 1, fig. 7.
1861. *Avicula linguaeformis* Gabb, Synop. Moll. Cret. Form., p. 158 (102).
1861. *Avicula petrosa* Gabb, Synop. Moll. Cret. Form., p. 158 (102).
1864. *Pteria linguiformis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 9.
1864. *Pteria petrosa* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 9.
1876. *Pteria linguiformis* Meek, Inv. Cret. and Ter. Foss. Up. Mo., p. 32, pl. 16, figs. 1 a-d.
1879. *Pteria linguiformis* White, 11th Ann. Rep. U. S. Geol. and Geog. Surv. Terr., pp. 180, 197, 205.
1880. *Pteria linguiformis* Whitf., Geol. Black Hills of Dak., p. 384, pl. 7, figs. 2, 3.
1885. *Pteria linguiformis* Whit., Cont. Can. Pal., vol. 1, pt. 1, p. 31.
1886. *Pteria petrosa* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 68, pl. 14, fig. 10.

Description.—Shell oblique, winged in front and behind, the hinge-line straight with the beaks in front of the middle. Both valves rather strongly convex, but the left a little more so than the right. Posterior wing compressed, of moderate length, pointed behind, its posterior margin concave; anterior wing narrower, pointed in front, less compressed than the other, its free margin nearly straight or slightly concave; in the right valve it is separated from the body of the shell by a narrow and shallow sulcus which extends from the anterior side of the beak downward and usually a little obliquely backward to the antero-ventral margin; just in front of the marginal extremity of this sulcus the surface is slightly bulged so as to leave a byssal opening between the valves. The antero-ventral margin slopes obliquely backward from the anterior extremity of the hinge-line; it is slightly concave to the base of the anterior wing beyond which point it becomes slightly convex, curving more and more below into the rounded postero-basal margin; the posterior margin oblique below and sinuate above. Surface of the shell marked only by concentric lines of growth which are inconspicuous on the internal casts.

The dimensions of a large specimen are: length from the anterior extremity of the hinge-line to the postero-basal margin, 51 mm.; length of hinge-line, 37 mm.; distance of beak from the anterior extremity of hinge-line, 12 mm.; convexity of right valve, 10 mm.

Remarks.—This species has always been considered one of the rare forms in the New Jersey Cretaceous faunas. Whitfield saw only one individual from near Keyport, and this specimen, aside from the type which is stated to be from Delaware, is the only one on record. In the recent collections of the Survey, the species occurs in abundance in the nodules from the Cliffwood clays, and less commonly from the summit of the Wenonah sand. Whitfield's specimen from "at or near Keyport" most probably was collected from the Cliffwood nodules at Cliffwood Point. Different individuals of the species show considerable variation in the obliquity of the shell, and also in the extension of the posterior wing, although the variation in this latter character

may be apparent rather than real on account of imperfections in the specimens. The specimen illustrated by Whitfield has the posterior wing almost entirely lacking, and the anterior wing is also incomplete, as it has never been observed when complete with the rounded outline shown by that author. The specimens from the Wenonah sand are not so large as those from the Cliffwood clay, but they agree with them in all essential respects.

These New Jersey specimens do not seem to possess any characteristics to distinguish them from the western shell described by Evans and Shumard as *Avicula linguaeformis*, and that name must undoubtedly be considered as a synonym of Conrad's species. Some of the New Jersey specimens are more oblique than the western shell as illustrated by Meek, but others possess essentially the same form.

Formation and locality.—Cliffwood clay, Cliffwood Point (105), near Matawan (186, 189); Wenonah sand, near Marlboro (130), near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey, Colorado, South Dakota, Canada (N. W.).

Pteria laripes (Morton).

Plate XLII., Fig. 3.

1834. *Avicula laripes* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 63, pl. 17, fig. 5.
1861. *Avicula laripes* Gabb, Synop. Moll. Cret. Form., p. 158 (102).
1864. *Pteria laripes* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 9.
1886. *Pteria laripes* Whitf. Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 69, pl. 14, fig. 9.
1905. *Pteria laripes* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 10.

Description.—"Shell of but moderate size, oblique ovate and moderately convex, with rather prominent beaks. Hinge less than half the length of the body of the shell, forming on the posterior side a proportionally large wing, which is obtusely pointed

at the extremity and only shallowly sinuate on the outer margin between the hinge line and body of the shell. Anterior wing unknown. Surface of the shell, on the left valve, strongly marked by distant elevated radii, which seem to have been alternately coarse and fine on the posterior half of the valve, judging from the only cast examined, and equal in strength and moderately curved forward on the anterior half; while the margin of the valve seems to have been marked by strongly projecting points corresponding to the ribs." (Whitfield.)

Remarks.—There is some question as to the occurrence of this species in New Jersey. The specimen used by Whitfield is probably the type of the species which was said to have come from Delaware by Morton in connection with his original description, but according to Whitfield it is distinctly marked "N. J." in the collection of the Philadelphia Academy. It has not been met with in the recent collections of the Survey, and because of this, and the uncertainty of its locality, it is not possible to determine its horizon. It should probably be looked for, however, in the horizon of the Merchantville clay-marl, or perhaps in the Cliffwood clay.

Formation and locality.—Unknown.

Geographic distribution.—New Jersey ?

Pteria navicula Whitfield.

Plate XLII., Fig. 4.

1886. *Pteria navicula* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 70, pl. 14, fig. 8.

1905. *Pteria navicula* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 10.

Description.—"Shell of small size, the greatest length being less than half an inch; very oblique and angularly ventricose, the height scarcely more than half the length. Hinge line nearly as long as the body of the shell, mucronate and slightly prolonged at the posterior extremity, which is separated from the body of the shell by a slight sinuosity. Anterior wing, if any, not preserved on the specimen; but the shell, although somewhat im-

perfect, does not appear to have been winged on the anterior side. Posterior extremity of the body of the (left) valve obtusely pointed, and the anterior end narrowly rounded from the extremity of the cardinal line. Basal line broadly curved, gradually descending from the anterior end to about the posterior third of the length, where it again rises to the extremity. Beaks small, rising a little above the hinge line, and prominently ventricose. Surface of the shell marked only by concentric striæ, so far as can be determined from the partially exfoliated individual. Right valve unknown." (Whitfield.)

Remarks.—This species was described from a single specimen of a left valve, and but a single example has been met with in the recent collections of the Survey.

Formation and locality.—Woodbury clay, Haddonfield (183); Red Bank sand, near Middletown (112).

Geographic distribution.—New Jersey.

Genus MELEAGRINELLA Whitfield.

Meleagrinella abrupta (Conrad).

Plate XLII., Figs. 5–9.

1853. *Avicula abrupta* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 274, pl. 24, figs. 5-6.
1861. *Avicula abrupta* Gabb, Synop. Moll. Cret. Form., p. 157 (101).
1864. *Pteria abrupta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 9.
1868. *Avicula abrupta* Con., Cook's Geol. N. J., p. 726.
1886. *Meleagrinella abrupta* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 72, pl. 14, figs. 11-14.
1905. *Meleagrinella abrupta* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 10.

Description.—"Shell small, inequivalve, rhombo-quadrate in outline, the hinge-line long and straight, reaching nearly the entire length of the shell, beaks small, situated at about the anterior third or fourth of the length of the hinge; that of the left valve rising a little above the cardinal line, and that of the

right just to its margin. Right valve with a deep notch-like slit on the anterior side just below the hinge, with a narrow, deep groove running from it to the apex of the valve on the exterior surface. Left valve provided with an internal fold, quite indistinct except under a glass, on the anterior side of the beak, which corresponds to the byssal notch of the right valve. Anterior margin of the valve somewhat regularly rounded; basal margin broadly rounded, and the posterior obliquely truncate, passing backward slightly from the hinge extremity to the postero-basal line. Surface of the valves smooth or very finely lamellose, and marked with concentric undulæ. When not at all worn or macerated the surface of the left valve shows indistinct thread-like, interrupted, radiating lines which remind one very strongly of those seen on species of *Placunomya.*" (Whitfield).

The dimensions of the right valve illustrated by Whitfield are: length, 14.5 mm.; height, 12 mm.

Remarks.—This species has been met with but rarely in the recent collections of the Survey.

Formation and locality.—Navesink marl, near Holmdel (128[3]), near Freehold (Whitfield).

Geographic distribution.—New Jersey.

Super-family OSTRACEA.

Family OSTREIDAE.

Genus Ostrea Linneus.

Ostrea cretacea Morton.

Plate XLII., Fig. 11.

1834. *Ostrea cretacea* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 52, pl. 19, fig. 3.

1860. *Ostrea cretacea* Owen, 2d Rep. Geol. Recon. Ark., pl. 7, fig. 7.

1861. *Ostrea cretacea* Gabb, Proc. Acad. Nat. Sci. Phil., 1861, p. 328.

1861. *Ostrea cretacea* Gabb, Synop. Moll. Cret. Form., p. 208 (152).

1869. *Ostrea cretacea* Coquand, Monog. Gen. Ost. Terr. Cret., p. 52, pl. 23, figs. 4-5.
1884. *Ostrea cretacea* White, 4th Ann. Rep. U. S. G. S., p. 294.
1905. *Ostrea cretacea* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 10.

Description.—Shell nonplicate, irregularly subovate in outline, higher than wide, narrowest across the hinge-line; the dimensions of a rather short, nearly complete internal cast of a lower valve are: height, 22.5 mm.; width, 18.5 mm. Lower valve moderately convex, upper valve nearly flat, surfact of the casts marked only by more or less irregular concentric undulations.

Remarks.—The shells which have been identified as *Ostrea cretacea* in the recent New Jersey collections, occur only in the form of internal casts in the Cliffwood clay. In so far as the characters of the specimens are preserved, they seem to agree in all essential characters with authentic representatives of this species from the south. Morton originally described the species as coming from the Cretaceous, but more recent authors have sometimes referred it to the Tertiary, but the Cretaceous age of the species is sufficiently demonstrated by the collections in the National Museum at Washington made by Dr. T. W. Stanton, who has found it to be especially characteristic of the lower beds of Ripley age in the Chattahoochie River section.

Formation and locality.—Cliffwood clay, Cliffwood Point (105).

Geographical distribution.—New Jersey, Georgia, Alabama, Arkansas.

Ostrea congesta Conrad?

Plate XLIII., Fig. 16.

1843. *Ostrea congesta* Con., Nicollet's Rep. Expl. N. W., p. 167.
1856. *Ostrea congesta* Hall, Pac. R. R. Rep., vol. 3, p. 100, pl. 1, fig. 11.
1869. *Ostrea congesta* Coquand, Monog. Gen. Ostrea Terr. Cret., p. 49, pl. 17, fig. 5.
1876. *Ostrea congest* Meek, Inv. Cret. and Ter. Foss. Up. Mo., p. 13, pl. 9, figs. 1, a-f.

1884. *Ostrea congesta* White, 4th Ann. Rep. U. S. G. S., p. 294, pl. 39, figs. 11-13.
1893. *Ostrea congesta* Stant., Bull. U. S. G. S., No. 106, p. 55, pl. 2, figs. 2-4.

Description.—Shell small, the individuals often crowded closely together in considerable numbers, so as to assume quite irregular forms. Surface of attachment of the lower valve large, beyond which the margin of the shell is abruptly deflected upward at right angles to the attached portion; upper valve flat or a little concave, having the form of the attached portion of the lower valve.

The dimensions of a specimen referred to the species are: length, 12.5 mm.; width, 15 mm.

Remarks.—A number of individuals of a small oyster have been observed in the Cliffwood clays which seem to belong to this species. The species may be recognized chiefly by the proportionately large area of attachment, with the abruptly deflected margins of the lower valve.

Formation and locality.—Cliffwood clay, Cliffwood Point (105).

Geographic distribution. New Jersey, Kansas, Nebraska, South Dakota, Colorado, New Mexico.

Ostrea denticulifera Conrad.

Plate XLIII., Figs. 1–2.

1858. *Ostrea denticulifera* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 330, pl. 34, figs. 1 and 8.
1861. *Ostrea denticulifera* Gabb, Synop. Moll. Cret. Form., p. 208 (152).
1864. *Ostrea denticulifera* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 6.
1868. *Ostrea denticulifera* Con., Cook's Geol. N. J., p. 724.
1869. *Ostrea denticulifera* Coquand, Monog. Gen. Ostrea Terr. Cret., p. 50, pl. 17, figs. 8-9.
1884. *Ostrea denticulifera* White, 4th Ann. Rep. U. S. G. S., p. 295.

1886. *Ostrea denticulifera* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 29, pl. 3, figs. 8-9.

1905. *Ostrea denticulifera* Johns., Proc. Acad, Nat. Sci. Phil. (1905), p. 10.

Description.—"The shells of this species are very small, flattened, thick, and extremely irregular in form. Those originally described by the author seem to have been moderately convex, but the New Jersey specimens are extremely shallow and generally elongated, with the surface obsoletely striate; even on the smoothest specimens the striæ show beneath the surface. The ligamental area is small and the margin crenulate on some individuals to near the front of the shell, the crenulations being strong and tooth-like, and leaving ridges on the sides of the valves as the shells thicken with age. Muscular impression large, lateral, and usually below the middle of the length." (Whitfield.)

Remarks.—This species has not been recognized in the recent collections of the Survey. The specimen illustrated by Whitfield is a Haddonfield example originally identified as belonging to the species by Conrad, the author of the species, but it is much more elongate and narrower than the original illustration of the species from Mississippi and it is quite possible that the identification is incorrect. In general form this Haddonfield example agrees more nearly with the specimens of *Ostrea plumosa,* but it is a thicker shell, and is not so distinctively marked by the fine radiating lines.

Formation and locality.—Woodbury clay, Haddonfield (183).

Geographic distribution.—New Jersey, Mississippi, Tennessee.

Ostrea panda Morton.

Plate XLII., Fig. 10.

1833. *Ostrea panda* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 293.

1834. *Ostrea panda* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 51, pl. 3, fig. 6, pl. 19, fig. 10.

1861. *Ostrea panda* Gabb, Proc. Acad. Nat. Sci. Phil., 1861, p. 328.

1861. *Ostrea panda* Gabb, Synop. Moll. Cret. Form., p. 209 (153).
1864. *Ostrea panda* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 6.
1868. *Ostrea panda* Con., Cook's Geol. N. J., p. 724.
1869. *Ostrea panda* Coquand, Monog. Gen. Ost. Terr. Cret., p. 57, pl. 30, figs. 8-9.
1884. *Ostrea panda* White, 4th Ann. Rep. U. S. G. S., p. 298.
1886. *Ostrea panda* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 30.

Description.—Shell rugose, irregularly subovate in outline; the dimensions of a nearly complete lower valve are: height, 21.5 mm; width, 26 mm.; free margins of the valves corrugated by rather broad, rounded plications which do not extend to the beak, those towards the cardinal margins becoming smaller; shell also marked by more or less irregular concentric lines of growth which are sublamellose upon some portions of the valve; beak rather sharply pointed and separated from the hinge-line by a flat, triangular, cardinal area whose surface lies nearly at a right angle to the general plane of the valve. The upper valve not recognized in the New Jersey collections.

Remarks.—This species was originally described from the Cretaceous of Delaware, but has usually been identified by more recent authors as a Tertiary species from the southern states. Judging from the Delaware locality given by Morton, St. George, the original specimens of the species must certainly have been from the Cretaceous. A single lower valve is present in the recent collections of the New Jersey Survey, which has been used as a basis for the description given above. This specimen seems to agree in all essential characters with Morton's original description and illustrations of the species, and it is believed that the identification is correct although the type specimens have not been available for comparison. The writer has not had the opportunity to determine the relationships of the southern Tertiary shell which has been identified by authors as *O. panda,* but it is altogether probable that it is a distinct specific form.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (180).

Geographic distribution.—New Jersey, Delaware, Alabama, Tennessee.

Ostrea plumosa Morton.

Plate XLII., Figs. 16–18.

1833. *Ostrea plumosa* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 293.
1834. *Ostrea plumosa* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 51, pl. 3, fig. 9.
1861. *Ostrea plumosa* Gabb, Synop. Moll. Cret. Form., p. 209 (153).
1864. *Ostrea plumosa* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 6.
1868. *Ostrea plumosa* Con., Cook's Geol. N. J., p. 724.
1869. *Ostrea plumosa* Coquand, Monog. Gen. Ostrea Terr. Cret., p. 61, pl. 32, fig. 9.
1876. *Ostrea plumosa* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 320.
1884. *Ostrea plumosa* White, 4th Ann. Rep. U. S. G. S., p. 299, pl. 37, figs. 5-6.
1886. *Ostrea plumosa* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 31, pl. 3, figs. 12-13.
1886. *Anomia argentaria* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), pl. 4, fig. 9 (not figs. 10-11).
1905. *Ostrea plumosa* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 10.

Description.—"Shell small, ovate, ovate-triangular or elongate-spatulate, thin and somewhat fragile irregularly convex on the upper valve, often subangulated longitudinally, either along one side or the other, beak of the upper valve thin, sharp and pointed; the ligamental area small and inconspicuous in most cases, though sometimes of moderate size. Exterior of the upper valve marked by obscure plications in all the type specimens, which cross the valve obliquely in either direction from right to

left or oppositely; also by fine radiating striæ which obscurely diverge from a more or less median line and pass toward the margin on either side. On the interior the margin of the valve near the apex is more or less crenulate. The muscular scar is small and lateral. Lower valve not yet observed." (Whitfield.)

The dimensions of a rather small individual are: length, 32 mm.; width, 16.3 mm.

Remarks.—This species is not uncommon at some horizons in the Cretaceous beds of New Jersey. In the Marshalltown clay-marl near Swedesboro it occurs with the shell preserved, and in the Wenonah sand near Crawfords Corner it is one of the most abundant species but is always in the form of casts. From the last of these localities some of the large individuals must have attained a length of 50 mm. or more. The rather oblique, somewhat obscure plications shown upon the specimens illustrated by Whitfield are doubtless due to the fact that those individuals, during their life, were attached to the surface of some plicated shell such as *Exogyra costata*. This plication of the shell is not an essential specific character and has not been detected upon any of the recently collected specimens. The fine radiating striæ, however, are highly characteristic of the species and can be detected upon all examples retaining the shell and upon all impressions of the external surface. Different individuals vary more or less in general outline, but the elongate, narrow form, somewhat acuminate towards the beak, seems to be the normal form of the species.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177); Wenonah sand, near Crawfords Corner (126[3]); Red Bank sand, Shrewsbury River (119).

Geographic distribution.—New Jersey, Alabama, Tennessee.

Ostrea subspatulata Forbes.

Plate XLII., Fig. 15.

1845. *Ostrea subspatulata* Forbes, Quart. Jour. Geol. Soc. Lond., vol. 1, p. 61, text figs. pp. 61 and 62.

1857. *Ostrea subspatulata* Con., Mex Bound. Surv., vol. 1, pt. 2, p. 155, pl. 10, figs. 3a, 3b.

1861. *Ostrea subspatulata* Gabb, Synop. Moll. Cret. Form., p. 210 (154).
1864. *Ostrea subspatulata* Meek, Check List Inv. Foss N. A., Cret. and Jur., p. 6.
1868. *Ostrea subspatula* Con., Cook's Geol. N. J., p. 724.
1869. *Ostrea subspatulata* Coquand, Monog. Gen. Ostrea Terr. Cret., p. 43, pl. 15, fig. 3.
1876. *Ostrea subspatulata* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 320.
1884. *Ostrea subspatulata* White, 4th Ann. Rep. U. S. G. S., p. 301, pl. 37, figs. 1-2.
1886. *Ostrea subspatulata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 32, pl. 3, fig. 14.

Description.—Shell subovate in outline, higher than wide, usually widest below the middle, the dimensions of a nearly complete cast of the interior of a lower valve are: length, 45 mm.; width, 31 mm. Lower valve strongly arcuate longitudinally, the cast nearly smooth or with a few obscure concentric undulations, the muscular impression large, situated in the lower left-hand quarter of the cast. The impressions of the exterior of the shell show rather strong concentric undulations.

Remarks.—In New Jersey this species is only known in the form of casts, none of which have been observed to attain so large dimensions as some of the examples from the South. The most characteristic feature of the species is its strongly arcuate form longitudinally, a feature which is even more conspicuous in the shell itself than in the casts because of the great thickening of the shell in its central part.

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]); near Marlboro (130[1]).

Geographic distribution.—New Jersey, Georgia.

Ostrea crenulimarginata Gabb.

Plate XLII., Figs. 12–13.

1860. *Ostrea crenulimarginata* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 398, pl. 68, figs. 40-41.
1861. *Ostrea crenulimarginata* Gabb, Synop. Moll. Cret. Form., p. 208 (152).

1864. *Ostrea crenulimarginata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 6.

1869. *Ostrea crenulimarginata* Coquand, Monog. Gen. Ostrea Terr. Cret., p. 51, pl. 17, figs. 12-13.

1884. *Ostrea crenulimarginata* White, 4th Ann. Rep. U. S. G. S., p. 294, pl. 40, fig. 2.

1886. *Ostrea crenulimarginata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 30, pl. 3, figs. 10-11.

Description.—"Shell, as seen in a single upper valve, depressed convex and moderately smooth, of an irregular ovate outline, and marked by but few concentric lines of growth more prominent than striæ. Faint indications of radiating striæ show obscurely, but are more in the substance of the shell than on the surface. On the interior the margin is finely crenulate for two-thirds the length of the valve, being strongest near the hinge and becoming fainter in the forward part. Muscular scar large, reniform, and situated above the middle of the shell." (Whitfield.)

The dimensions of a large example are: height, 47 mm.; length, 44 mm.

Remarks.—No specimens referable to this species have been observed in the recent collections. Whitfield has illustrated one specimen which he has so identified, but it is quite unlike Gabb's original figure of the species in being much broader along the hinge-line. It seems to have the crenulations along the margin similar to those upon Gabb's specimen, and the identification may be correct.

Formation and locality.—Navesink marl, Marlboro (Whitfield).

Geographic distribution.—New Jersey, Tennessee.

Ostrea monmouthensis n. sp.

Plate XLIII., Fig. 15.

Description.—Shell slightly oblique, subovate in outline, the dimensions of the type specimen being: length, 28 mm.; width, 22 mm. Upper valve depressed convex, nearly smooth, marked only by inconspicuous concentric lines of growth. Along the

ventral margin the edge is folded into sharply angular teeth which do not extend as plications into the body of the shell, these tooth-like crenulations becoming smaller and at last disappearing upon the lateral margins of the shell. Lower valve not known.

Remarks.—It is with some hesitation that a species of so variable a group of shells as the oysters has been proposed for a single specimen, but it has not been possible to identify it with any of the described forms, and it seems to be so distinct that it is probable that additional examples, should they be found, could be recognized without difficulty. The shell has much the general outline of the specimen referred to *O. crenulimarginata* by Whitfield, but that shell entirely lacks the characteristic denticulation of the ventral margin of this species.

Formation and locality.—Navesink marl, near Crawfords Corner (126[7]).

Geographic distribution.—New Jersey.

Ostrea tecticosta Gabb.

Plate XLIII., Figs. 17–19.

1860. *Ostrea tecticosta* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 403, pl. 68, figs. 47-48.

1861. *Ostrea tecticosta* Gabb, Synop. Moll. Cret. Form., p. 210 (154).

1864. *Ostrea tecticosta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 6.

1868. *Ostrea tecticosta* Con., Cook's Geol. N. J., p. 724.

1869. *Ostrea tecticosta* Coquand, Monog. Gen. Ostrea Terr. Cret., p. 50, pl. 17, figs. 10-11.

1876. *Ostrea pusilla* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 321.

1884. *Ostrea tecticostata* White, 4th Ann. Rep. U. S. G. S., p. 301, pl. 17.

1886. *Ostrea tecticosta* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 33, pl. 3, figs. 1-2.

1905. *Ostrea tecticosta* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 10.

Description.—"Shell small, elongate, oval, ovate or irregularly elliptical in outline, slightly curved, with a small, strongly-twisted beak and moderately-sized ligamental area on the lower valve. The lower valve usually shows a large cicatrized area of attachment and is strongly plicated, the plica being usually sharply rounded and very rugose from concentric lamellose lining. The inner margins of the valves are also crenulated on the upper half or two-thirds of their length, and more minutely so on the inner border at the junction of the valves just below the ligamental area. Muscular scar large, but only moderately marked. Upper valves slightly convex and destitute of plications except near the border." (Whitfield.)

Remarks.—This species was originally described from specimens whose horizon is unknown, although they probably came from some of the beds below the Navesink marl. The specimens which have been so identified in the recent collections of the Survey, are more or less imperfect casts from the Wenonah sand near Marlboro. In general these Wenonah specimens somewhat resemble the *O. larva* type of oysters, but the lower valve was apparently attached uniformly by a much larger area than any of the New Jersey forms here referred to *O. falcata, O. mesenterica,* and *O. nasuta,* and some of the specimens agree very well with the type of the species except that they are modified casts while the type has the shell itself preserved.

Formation and locality.—Wenonah sand, near Marlboro (130).

Geographic distribution.—New Jersey.

Ostrea falcata Morton.

Plate XLIII., Figs. 3–6.

1830. *Ostrea falcata* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 50, pl. 1, fig. 2.

1830. *Ostrea falcata* Mort., Am. Jour. Sci., 1st ser., vol. 17, p. 284; vol. 18, pl. 3, figs. 19-20.

1834. *Ostrea falcata* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 50, pl. 3, fig. 5.

1860. *Ostrea falcata* Owen, 2nd Rep. Geol. Recon. Ark., pl. 7, fig. 5.
1861. *Ostrea falcata* Gabb, Synop. Moll. Cret. Form., p. 208 (152).
1868. *Ostrea larva* Cook, Geol. N. J., p. 375, fig.
1884. *Ostrea* (*Alectryonia*) *larva* White (in part), 4th Ann. Rep. U. S. G. S., p. 296, pl. 42, fig. 8.
1886. *Ostrea larva* Whitf. (in part), Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 34, pl. 3, figs. 3-7.
1905. *Ostrea falcata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 11.

Description.—Shell of medium size, laterally arcuate. The dimensions of an average specimen are: length along the arcuate median line from beak to posterior extremity, 47 mm.; distance between beak and posterior extremity, 28 mm.; width of shell at middle, 16 mm.; length of hinge-line, 20 mm. Shell usually more or less strongly auriculate, the ears subequal or with one ear somewhat larger than the other. Hinge-line straight. Shell marked with from seven to ten deep plications which originate along the lower or convex margin and extend nearly to the beak, not leaving a conspicuous non-plicate central area, the plications towards the anterior hinge extremity decreasing regularly in size; along the upper or concave margin the shell is marked by a series of short, marginal plications. Lower valve moderately convex, with a small scar of attachment; upper valve much flatter, its plications similar to those of the lower valve.

Remarks.—This species, as observed in New Jersey, is most abundantly represented in the Marshalltown marl, where it sometimes occurs in innumerable individuals. In its laterally arcuate form it resembles *O. mesenterica,* but it differs from that species in its larger size, and in its more strongly plicated shell, there being no central non-plicate area as in that species. The specimens vary greatly in the form and size of the auriculations, and to some extent in the number of plications, but not so much in this latter respect as does *O. mesenterica.* Both of these species have usually been considered as members of a single species, *O.*

larva, but they are clearly distinct, and are for the most part restricted to different geologic horizons, and in the New Jersey faunas, at least, do not have intermediate connecting forms. Their relationship to the true *O. larva* must be investigated.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177); Navesink marl, near New Egypt (147[2]); near Red Bank (120), Crosswicks Creek (195).

Geographic distribution.—New Jersey, Arkansas.

Ostrea mesenterica Morton.

Plate XLIII., Figs. 9–14.

1834. *Ostrea falcata* var. B (*O. mesenterica*) Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 51, pl. 9, fig. 7.
1861. *Ostrea mesenterica* Gabb, Synop. Moll. Cret. Form., p. 209 (153).
1884. *Ostrea* (*Alectryonia*) *larva* White in (in part), 4th Ann. Rep. U. S. G. S., p. 296, pl. 42, figs. 6-7.
1886. *Ostrea larva* Whitf. (in part), Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 34, pl. 3, figs. 3-7.

Description.—Shell small, laterally arcuate. The dimensions of an average specimen are: length along the arcuate median line from the beak to the posterior extremity 32 mm., distance between beak and posterior extremity 26 mm.; width of shell at middle, 9 mm. Shell usually auriculate, the ears variable in size and sometimes nearly obsolete, the posterior usually larger than the anterior. Shell strongly plicate along its lower convex margin, the plications variable in number and size, not extending into the median portion of the shell, those near the hinge-line notably smaller than those in the middle of the shell; the plications of the upper concave margin much smaller than those of the convex margin. Central area of the shell marked only by the concentric lines of growth. Lower valve moderately convex, the scar of attachment variable, but usually small and restricted to the apical region; upper valve flat.

Remarks.—This little oyster is extremely abundant in the Navesink marl, and has not been observed in any of the beds

below that horizon in New Jersey. It is one of several forms of the type of *O. larva* in the New Jersey faunas, and can always be distinguished by its small size and the nonplicate central area of the shell. The number of plications along the convex margin is exceedingly variable, a fact which can be best observed in the larger plications along the lower or convex margin of the shell, excluding the smaller ones near the extremity of the hinge-line, the number varying from four to as many as nine or ten. The species resembles *O. pellucida* M. & H.[1] in its marginal plications, but differs from that species in the presence of the auriculations at the extremities of the hinge-line, and in the small area of attachment, although a specimen is occasionally met with that shows that it has been attached for nearly half the length of the shell.

Formation and locality.—Navesink marl, near Holmdel (127, 128[5], 194), Oak Hill (121), Atlantic Highlands (108), Middletown (113[2]), near Red Bank (120), near Crawfords Corner (126[7]), Marlboro (131), Crosswicks Creek (149, 147[4], 195), near Jacobstown (150), Mullica Hill (169[2]); Red Bank sand, Shrewsbury River (119, 116); Tinton beds, Tinton Falls (110), near Freehold (132).

Geographic distribution.—New Jersey.

Ostrea nasuta Morton.

Plate XLIII., Figs. 7–8.

1834. *Ostrea falcata* Var. A (*O. nasuta*) Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 51, pl. 9, fig. 6.

1861. *Ostrea nasuta* Gabb, Synop. Moll. Cret. Form., p. 209 (153).

1884. *Ostrea* (*Alectryonia*) *larva* White (in part), 4th Ann. Rep. U. S. G. S., p. 296, pl. 42, figs. 2-5, 9.

1886. *Ostrea larva* var. *nasuta* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 35, pl. 3, figs. 3-4.

1902. *Ostrea larva* Hill and Vaughan, U. S. G. S., Geol. Atlas, Austin Folio, fig. 50.

[1] Meek, Rep. Inv., Cret. and Terr. Foss. Up. Mo., p. 15, pl. 28, figs. 4a-4b.

Description.—Shell of medium size, laterally arcuate. The dimensions of a rather small individual are: length along the median line from beak to posterior extremity, 45 mm.; distance between beak and posterior extremity, 21 mm.; width of shell at middle, 17 mm.; length of hinge-line, 12 mm. Shell more or less strongly auriculate, the auriculations variable in size. Hinge-line straight. Shell surface marked by from four to seven profound and broad plications along the lower or convex margin, which rapidly die out, leaving the central area of the shell nonplicate; the upper or concave margin marked by much smaller, short, marginal plications or denticulations. Lower valve moderately convex, with a small scar of attachment; upper valve flat. Entire surface of both valves marked by fine, more or less irregular, concentric lines of growth.

Remarks.—This species is a close ally of *O. mesenterica.* The two species agree in having the median portion of the shell nonplicate, but *O. nasuta* is a much larger and coarser shell, with broader and more profound plications. It should, perhaps, be considered only as a varietal form of *O. mesenterica,* but it is for the most part characteristic in New Jersey, of higher beds than the Navesink marl, where that species is most abundant. The two forms usually do not occur in association, and it is at least convenient to have a special name for the designation of this form.

Formation and locality.—Navesink marl, near Red Bank (120); Red Bank Sand, Red Bank (116, 123), near Middletown (112); Tinton beds, Beers Hill cut, south of Keyport (129^9), near Freehold (132), near Red Valley (123).

Geographic distribution.—New Jersey, Texas.

Ostrea bryani Gabb.

Plate XLIV., Figs. 1–5.

1876. *Ostrea bryani* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 321.
1884. *Ostrea bryani* White, 4th Ann. Rep. U. S. G. S., p. 293.
1886. *Gryphæa bryani* var. *precedens* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 194, pl. 26, figs. 7-8.

1886. *Gryphæa bryani* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 206, pl. 27, figs. 6-9.

1886. *Ostrea glandiformis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 205, pl. 27, figs. 1-5.

1905. *Gryphæa bryani* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 11.

Description.—Shell oblique, more or less strongly extended laterally to the left, looking upon the upper valve; moderately thick, more or less subtrigonal or subovate and exceedingly irregular in outline. Lower valve strongly or moderately and very irregularly convex, sometimes flattened or even concave to beyond the middle of its length, attached or free, the scar of attachment variable, usually small or of moderate size; surface markings exceedingly irregular, consisting of concentric, more or less squamose lines, which are often produced into irregularly spinose processes near the hinge-line in those specimens which have been strongly attached; surface also marked on many examples, by a few rather broad, irregular, radiating costæ; hinge-area triangular, with a deep ligamental groove in the middle, whose apex is deflected to the left. Upper valve flat, slightly concave or slightly convex, sometimes convex towards the beak, becoming concave towards the base, the surface marked by concentric squamose lines, the hinge area directed from 45° to 90° to the general plane of the valve.

The dimensions of an average-sized, rather convex, lower valve are: greatest length, obliquely from the beak to the postero-basal margin, 42 mm.; greatest width at about right angles to the last dimension, 28 mm.; convexity, 19 mm.

Remarks.—This is an exceedingly variable shell, and apparently includes not only *Ostrea bryani* as described by Gabb, and referred to the genus *Gryphæa* by Whitfield, but also *Gryphaea bryani* var. *precedens* Whitf. and *Ostrea glandiformis* Whitf. In a collection of one hundred or more individuals from the typical locality for the species near Vincentown, specimens can be selected to represent all three of these forms, with all gradations between. Some of the larger and more convex speci-

mens more or less closely resemble *Gryphaea convexa,* in miniature, even to the oblique posterior constriction and the consequent auriculation of the shell, and Whitfield has referred the species to the genus *Gryphaea* instead of *Ostrea.* The convex valve, however, in most cases gives evidence of having been attached, and the beak is usually not strongly incurved, characters which would seem to ally the species to the genus *Ostrea* rather than *Gryphaea.* Those types of Whitfield's *O. glandiformis* which preserve the shell are a perfectly normal upper valve of *O. bryani* and one of the more shallow lower valves of the same species. The most common occurrence of the species is in the form of internal casts such as is illustrated by Whitfield under the name *O. glandiformis.* Only at the marl pits near Vincentown have the shells themselves been found abundantly.

Formation and locality.—Vincentown limesand, near New Egypt (Whitfield); Manasquan marl, near Vincentown (159), near Farmingdale (138), near New Egypt (155).

Geographic distributilon.—New Jersey.

Genus GRYPHAEA Lamark.

All the specimens of *Gryphaea* in the Cretaceous beds of New Jersey have usually been referred to a single species, *G. vesicularis* Lam. In the present report this usage has been departed from and three distinct forms have been recognized. These forms are distinct varieties, at least, are easily recognized, are characteristic of distinct horizons, and are connected by very few or no intermediate forms. There may be differences of opinion as to the advisability of recognizing them as of specific rank, but it really makes little difference whether they be considered as varieties or as species. It is certainly more convenient to designate a given form by a single name rather than by two, and so the names are considered to be of specific rank in this connection.

Gryphaea convexa (Say).

Plate XLV., Figs. 1–2.

1820. *Ostrea convexa* Say, Am. Jour. Sci., 1st ser., vol. 2, p. 42.
1828. *Gryphæa convexa* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 79, pl. 4, figs. 1-2.
1829. *Gryphæa convexa* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 121.
1830. *Gryphæa convexa* Mort., Am. Jour. Sci. 1st ser., vol. 17, p. 283.
1834. *Gryphæa convexa* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 53, pl. 4, figs. 1-2.
1840. *Gryphæa convexa* Troost, 5th Geol. Rep. Tenn., p. 46.
1868. *Pycnodonta vesicularis* Cook, Geol. N. J., p. 374, figs.
1884. *Gryphæa vesicularis* White (in part), 4th Ann. Rep. U. S. G. S., p. 303, pl. 48, figs. 1-5.
1886. *Gryphæa vesicularis* Whitf. (in part), Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 36, pl. 3, fig. 15, pl. 4, figs. 1-2.
1902. *Gryphæa vesicularis* Hill and Vaughan, U. S. G. S., Geol. Atlas, Austin Folio, fig. 51.
1905. *Gryphæa convexa* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 11.

Description.—Shell variable in outline, large and robust, oblique, very thick, the surface more or less rugose, the beak in front of middle of the shell. Lower valve strongly convex, more or less auriculate posteriorly, the auriculation separated from the body of the shell by a conspicuous sinus which extends from behind the beak obliquely backward to the posterior margin of the shell, the cardinal side of the auriculation usually flattened and somewhat elevated; the body of the shell most strongly elevated along a line which extends obliquely backward from the beak to the basal margin, this prominence being more or less rounded or in some cases almost subangular; the posterior slope of the shell surface to the sinus limiting the auriculation is usually more abrupt than the anterior slope. The scar of attachment

usually inconspciuous. Upper valve nearly flat or slightly concave. The dimensions of a rather large convex valve are: length, 105 mm.; height, 98 mm.; convexity, 58 mm.

Remarks.—It is this species of *Gryphaea* which makes up in large part, the conspicuous shell bed in the midst of the Navesink marl, and it is rarely or never associated in this horizon with any other member of the genus. The species is especially characterized by its strongly convex lower valve, the anterior position of the beak, the conspicuous posterior auriculation and the more or less rugose surface. The shells are extremely variable in general form and outline, as is the case with all species of this group, but the characters mentioned above, although variable in degree of development and in minor details, are apparently constant, and there is rarely any difficulty in separating this form from the others recognized in this report.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (180); Navesink marl, Middletown (113^2), near Crawfords Corner (126^7), near Holmdel (128^3, 128^5, 127, 194), Marlboro (131), near Walnford (148^2), Crosswicks Creek (149, 147^2, 147^4, 195), near Jacobstown (150), Mullica Hill (169^2).

Geographic distribution.—New Jersey, Alabama, Mississippi.

Gryphaea mutabilis Morton.

Plate XLVI., Fig. 1.

1828. *Gryphæa mutabilis* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 81, pl. 4, fig. 4.

1830. *Gryphæa mutabilis* Mort., Am. Jour. Sci., 1st ser., vol. 17, p. 283.

1834. *Gryphæa mutabilis* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 53, pl. 4, fig. 3.

1884. *Gryphæa vesicularis* White (in part), 4th Ann. Rep. U. S. G. S., p. 303, pl. 48, figs. 1-5.

1886. *Gryphæa vesicularis var. mutabilis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 38, pl. 3, fig. 16; pl. 4, fig. 3; pl. 5, figs. 1-3.

1905. *Gryphæa mutabilis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 11.

Description.—Shell more or less subcircular in outline, the beak subcentral, the hinge-line usually nearly straight. The lower valve depressed convex usually somewhat compressed towards the cardinal extremities, the posterior constriction and auriculation obsolete or scarcely distinguishable. The upper valve nearly flat or moderately concave. Surface of the shell marked with concentric, more or less squamose lines of growth. Shell substance moderately thick. Scar of attachment small or of moderate size.

The dimensions of an ordinary lower valve are: length, 110 mm.; height, 96 mm.; convexity, 33 mm.

Remarks.—This form is especially characteristic of the Marshalltown marl, and it differs from *G. convexa* of the Navesink, in its more depressed convex lower valve, in its thinner shell and in the absence of the conspicuous posterior constriction and auriculation of the lower valve. The two species are sometimes associated in the Marshalltown formation, but specimens are rarely met with which cannot be placed without hesitation in either the one or the other species. In the Navesink marl this species is rarely or never met with

Formation and locality. — Marshalltown clay-marl, near Swedesboro (177, 179, 180).

Geographic distribution.—New Jersey.

Gryphaea dissimilaris n. sp.

Plate XLVI., Figs. 2–3.

Description.—Shell thin or of moderate thickness, somewhat oblique, variable in outline, but usually more or less subovate, usually wider than long, the beak subcentral or in front of the center. Lower valve usually strongly convex, with the beak incurved, often with a slight or moderate constriction passing from the posterior side of the beak to the posterior margin, limiting a more or less prominent posterior auriculation; in many specimens this constriction and consequent auriculation is entirely obsolete. Upper valve smaller, often very much smaller than the lower, deeply concave as a whole, although the portion near

the beak may be convex. Surface of both valves marked with more or less squamose concentric lines of growth.

The dimensions of an average lower or convex valve are: width, 69 mm.; length, 66 mm.; convexity, 38 mm.

Remarks.—This species approaches most closely to *G. convexa,* but it is almost always a smaller shell and it may be distinguished by several more or less constant characters. Perhaps the most important of these characters is the smaller and deeply concave upper valve; in those specimens preserving the two valves, the upper one is sometimes scarcely more than one-half the length of the lower. It is possible that in the living animal this shell had a thin calcareous extension to the margin of the lower valve, but in the fossil specimens this has often been entirely destroyed, if it ever were present. This species also differs from *G. convexa* in the much less conspicuous posterior auriculation of the shell; this is more or less a variable character in both species, and sometimes a strongly auriculate individual of *G. dissimilaris* does not differ materially from one of the less strongly auriculate individuals of *G. convexa,* but in such a case the two specimens would be sufficiently distinct by reason of the greater concavity of the upper valve of *G. dissimilaris.* The average conditions, however, of the two forms are widely separated. The shells of the two species differ materially in thickness, that of *G. convexa* usually grows to be ponderously thick in old individuals, while that of *G. dissimilaris* never attains more than a moderate thickness, and is often exceedingly thin and fragile for this group of molluscs; in any one locality all the shells of the species are of much the same character as regards thickness, and it is among the individuals from those localities where the shells are thinner that the upper valves are smallest; it is possible that this difference in the shell within the species itself is due to differences in the amount of calcium carbonate in the waters available for shell secretion by the molluscs, or to difference in depth of the waters in which it lived. Besides these differences in the characters of the shells, the two forms occur at entirely different horizons, and in no case have they been found associated together. Whitfield apparently referred this

shell to *G. aucella* Roem., first described from Texas, but the New Jersey shell is entirely different from the Texas specimens.

Formation and locality.—Hornerstown marl, near Woodstown (181), near New Egypt (142², 142³), near Mullica Hill (182).

Geographic distribution.—New Jersey.

Genus GRYPHAEOSTREA Conrad.

Gryphaeostrea vomer (Morton).

Plate XLIV., Figs. 6–11.

1834. *Gryphæa vomer* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 54, pl. 9, fig. 5.
1861. *Exogyra lateralis* Gabb, Synop. Moll. Cret. Form., p. 179 (123).
1864. *Exogyra lateralis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 6.
1868. *Gryphostrea lateralis* Con., Cook's Geol. N. J., p. 724.
1876. *Gryphæostrea vomer* Meek, Rep. Inv. Cret. and Tert. Foss. Up. Mo., p. 11.
1886. *Gryphæostrea vomer* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 195, pl. 26, figs. 11-12.
1901. *Ostrea (Gryphaeostrea) vomer* Clark, Eocene Rep., Geol. Surv. Md., p. 193, pl. 50, figs. 1-5.
1905. *Ostrea (Gryphæostrea) vomer* Johns., Proc. Acad. Nat. Sci. Phil., (1905), p. 11.

Description.—The dimensions of a rather large individual are: length, 55 mm.; greatest width, near the hinge-line, 33 mm. Shell narrowly elongate, subovate or subelliptical in outline, more or less strongly arcuate from beak to base, and often more or less twisted laterally. Lower or right valve more or less strongly convex, the beak small, pointing forward, a little coiled; in typically developed shells both the anterior and posterior cardinal regions are produced into compressed auricular extensions, one or both of which are frequently wanting; the surface of the valve nearly smooth or only slightly marked with concentric lamellose lines upon the body of the shell, the auricular extensions usually

more strongly lamellose. The upper or left valve usually concave longitudinally, flat or slightly concave transversely, the dorsal margin rounded, its cardinal regions not produced into auricular appendages, the beak curved anteriorly; surface marked by distinct and somewhat regular, elevated concentric ridges whose summits are produced as free lamellæ. Ligamental areas small or nearly obsolete.

Remarks.—This species is an abundant and long-ranging form in the New Jersey Cretaceous beds, and it is also known in the Eocene of the Atlantic coastal plane. It is an exceedingly variable shell, especially the lower or right valve, which is attached, the upper or left valve being much more constant in its characters. The specimens from the different horizons where it occurs all seem to be much the same, with no marked differences, such as have been noted in the case of members of the genera *Gryphaea* and *Exogyra*.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177, 180); Navesink marl, near Red Bank (120), Marlboro (131), Crosswicks Creek (149, 147[4], 195), near Jacobstown (150), near Mount Laurel (166), Mullica Hill (169); Red Bank sand, Red Bank (123); Hornerstown marl, near Woodstown (181); Vincentown limesand, near Farmingdale (134), New Egypt (143), Vincentown (154), near Hurffville (171, 170), near Alloway (196).

Geographic distribution.—New Jersey, Mississippi.

Genus EXOGYRA Say.

Exogyra costata Say.

Plate XLVII., Fig. 1.

1820. *Exogyra costata* Say, Am. Jour. Sci. 1st ser., vol. 2, p. 43.
1828. *Exogyra costata* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 85, pl. 6, figs. 1-4.
1830. *Exogyra costata* Mort., Am. Jour. Sci., 1st ser., vol. 17, p. 284.
1834. *Exogyra costata* Mort. Synop. Org. Rem. Cret. Gr. U. S., p. 55, pl. 6, figs. 1-4.

1852. *Exogyra costata* Roemer, Kreide von Texas, p. 72.
1854. *Exogyra costata* Con., Rep. U. S. and Mex. Bound. Surv., vol. 1, pt. 2, p. 154; pl. 8, fig. 3; pl. 9, figs. 1-2; pl. 10, fig. 1.
1858. *Exogyra costata* Emm., Rep. N. Car. Geol. Surv., p. 278, fig. A.
1860. *Exogyra costata* Owen, 2nd Rep. Geol. Reconn. Ark., pl. 7, fig. 4.
1861. *Exogyra costata* Gabb, Synop. Moll. Cret. Form., p. 178.
1864. *Exogyra costata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 6.
1868. *Exogyra costata* Con., Cook's Geol. N. J., p. 374, fig. 1, p. 724.
1876. *Exogyra costata* Gabb, Proc. Acad. Nat. Sci. Phil., 1876, p. 323.
1884. *Exogyra costata* White, 4th Ann. Rep. U. S. G. S., p. 304, pl. 51, figs. 1-2, pl. 57, figs. 1-2.
1886. *Exogyra costata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 18), p. 39 (in part).
1896. *Exogyra costata* Say, Bull. Am. Pal., vol. 1, p. 291 (No. 5, p. 21).
1902. *Exogyra costata* Hill and Vaughan, U. S. G. S., Geol. Atlas, Austin Folio, fig. 52.

Description.—"Shell large, thick, and ponderous, irregularly circular or subovate in outline, plano-convex in profile and obliquely coiled at the apex, the lower valve sometimes showing one and a half to nearly two volutions in well-preserved adult specimens. Convex valve deep, and on the back strongly angular, especially so in the earlier parts formed, the portion near the beak often being sharply carinate and smooth. Surface of the valve marked by strong radiating costæ, which are round on the surface, and separated by narrow depressions. Costæ frequently bifurcating, and radiating from or dividing along the umbonal ridge; one set curving toward the anterior side and the other toward the basal margin. Upper or left valve flat or slightly convex, often becoming slightly concave toward the antero-basal margin in advanced stages of growth, while in

many instances both valves conform in producing a deep sinuosity on the anterior side below the beaks. Surface of the flat valve very strongly lamellose on the posterior half, while showing incipient costæ on the anterior side below the apex." (Whitfield.)

Remarks.—All specimens of *Exogyra* from the New Jersey Cretaceous faunas have usually been placed together in a single species, *E. costata,* but two entirely distinct forms can be recognized, which are characteristic of distinct horizons, and no connecting varieties between the two forms have been detected in New Jersey. Say does not mention the locality of the type specimen of his species, except that it came from New Jersey, but it was probably collected at Mullica Hill, since all the other New Jersey Cretaceous species described in his paper, of which the locality is mentioned, are from that place, and furthermore, the species has been found to occur abundantly at that locality in the recent collections of the Survey. *E. costata* is characteristic of the Navesink fauna, and differs from *E. ponderosa* of the Marshalltown fauna, in its strongly costate shell, which, even in the largest individuals, does not develop the strong, concentric, lamellose extensions which are so characteristic of *E. ponderosa.*

Formation and locality.—Navesink marl, Atlantic Highlands (108), Middletown (113[1], 113[2]), near Red Bank (120), near Crawfords Corner (126[7]), near Holmdel (128[3], 127, 194), near Freehold (133), near Walnford (148[2]), Crosswicks Creek (149, 147[2], 147[3], 147[4], 195), near Jacobstown (150), near Mount Laurel (166), Mullica Hill (169[2]); Red Bank sand, Red Bank (119); Tinton beds, Beers Hill Cut, south of Keyport (129[5], 129[9]).

Geographic distribution.—New Jersey, Delaware, Alabama, Mississippi, Texas, Arkansas.

Exogyra ponderosa Rœmer.

Plate XLVII., Fig. 2.

1849. *Exogyra ponderosa* Roem., Texas, p. 395.
1852. *Exogyra ponderosa* Roem., Kreide von Texas, p. 71, Taf. 9, figs. 2 a-b.

1853. *Exogyra ponderosa* Shum., Marcy's Expl. Red. River La., p. 204.

1870. *Exogyra ponderosa* Credner, Zeitsch. Deutsch. Geol. Ges., Band 22, p. 229.

1875. *Exogyra ponderosa* White, Rep. Geog. and Geol. Expl. w. 100th, Mer., vol. 4, pl. 1, p. 172, pl. 14, figs. 1 a-c.

1884. *Exogyra ponderosa* White, 4th Ann. Rep. U. S. G. S., p. 306, pl. 50, figs. 1-3.

1886. *Exogyra costata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 18), p. 39 (in part), pl. 6, figs. 1-2.

1902. *Exogyra ponderosa* Hill and Vaughn, U. S. G. S., Geol. Atlas, Austin Folio, fig. 46.

Description.—Shell large, plano-convex, more or less subovate in outline. Lower or right valve strongly convex; beak strongly coiled; the surface more or less subangular along a line extending obliquely from the beak to the postero-ventral margin, the posterior slope convex, the anterior slope flattened towards the beak, irregularly flattened, slightly concave or convex below; surface marked by more or less distinct, rather broad and flat, more or less irregular, sometimes bifurcating costæ on the younger shells and on the umbonal portion of the adult shells, which become obsolete on the outer portion of full grown individuals, giving place to strong, concentric, lamellose extensions of the shell. Upper or left valve nearly flat, coiled at the apex, marked with conspicuous concentric lamellæ and by a few more or less indistinct radiating costæ on the antero-dorsal region.

The dimensions of a large individual are: height, 123 mm.; width, 114 mm.; convexity, 60 mm.

Remarks.—In the Cretaceous beds of New Jersey this species occurs only in the Marshalltown clay-marl, and it has not been found in association with *E. costata,* although these shells have usually been included in that species. In fact the illustration in Whitfield's monograph is really a figure of this species rather than of the true *E. costata.* The species differs from *E. costata* in the much weaker development of the radiating costæ and in the strong development of the concentric lamellæ.

In the South where the two species, *costata* and *ponderosa* occur, they have the same stratigraphic relations as in New Jersey, that is the *ponderosa* occurs in lower beds than the *costata*.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177).

Geographic distribution.—New Jersey, Alabama, Texas.

Exogyra sp.

Plate XLVII., Fig. 3.

In the Merchantville clay-marl the internal casts of a small *Exogyra* sometimes occur which cannot be certainly referred to either *E. costata* or *E. ponderosa*. They are always small, rarely attaining a width greater than 28 mm. Their external characters have not been observed.

Formation and locality.—Merchantville clay-marl, Lenola (163).

Geographic distribution.—New Jersey.

Super-family TRIGONIACEA.

Family TRIGONIIDAE.

Genus TRIGONIA Bruguière.

In certain of the faunas of the New Jersey Cretaceous, the genus *Trigonia* is abundantly represented, in others it is nearly or quite absent. Unfortunately, however, the specimens are nearly always represented by internal casts and impressions of the exterior, which latter are not always so preserved as to admit of being used for moulds to secure artificial casts. Four species are recognized in the present report, but several others are suggested among the recent collections of the Survey, but are too incomplete to allow of their proper description.

Trigonia thoracica Morton.

Plate XLVIII., Figs. 1–4.

1834. *Trigonia thoracica* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 65, pl. 15, fig. 13.

1852. *Trigonia thoracica* Roem., Kreid. von Texas, p. 52.

1860. *Trigonia thoracica* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 304, pl. 47, fig. 10.
1860. *Trigonia thoracica* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 304, pl. 47, fig. 10.
1861. *Trigonia thoracica* Gabb, Synop. Moll. Cret. Form., p. 233 (177).
1864. *Trigonia thoracia* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 9.
1868. *Trigonia thoracica* Con., Cook's Geol. N. J., p. 725.
1870. *Trigonia limbata* Credner, Zeitsch. Deutsch. Geol. Ges., Band 22, p. 234.
1876. *Trigonia thoracica* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 312.
1886. *Trigonia Mortoni* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 112, pl. 14, figs. 5-6.
1898. *Trigonia thoracica* Johns., Proc. Acad. Nat. Sci. Phil. (1898), p. 464.
1905. *Trigonia thoracica* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 11.

Description.—Shell large, the dimensions of an average sized individual being: length, 48 mm.; height, 42 mm.; convexity, 11 mm. Ovate subtrigonal in outline, the valves moderately convex in front, becoming compressed posteriorly; the beaks nearly anterior, slightly recurved. Anterior margin broadly rounded, passing into the ventral margin; ventral margin broadly rounded, often becoming a little straightened as it approaches the posterior extremity of the shell; posterior margin obliquely subtruncate above; dorsal margin gently concave from the beak to the posterior hinge extremity. Surface of the valve divided into two portions by an angular, curved furrow, passing backward from just behind the beak sub-parallel with the dorsal margin, to a point in the posterior margin of the shell a short distance below the posterior hinge extremity; the lower portion of the valve constitutes much the greater part and is marked by about fifteen ribs, about ten of which are very strong, subangular, more or less nodose, with broad concave

interspaces, and occupying the greater portion of the shell, the more anterior of these ribs are shorter and curve strongly forward, the more posterior ones curve slightly downward; between these strong ribs and the curved divisional furrow is a subtriangular area occupied by much smaller somewhat nodose furrows, which usually have a more or less distinct upward curvature as they approach the posterior border. The upper portion of the valves is divided into two regions, being nearly in the plane of the valve below and abruptly inflected above to the hinge-line, to form a long and rather broad escutcheon, this region is marked with 12 or 14 subangular ribs which originate along the divisional furrow, curving backward and upward across the escutcheon to the hinge-line. The entire surface is also marked by more or less irregular concentric lines of growth.

Remarks.—This is one of the most abundant species in the Marshalltown clay-marl near Swedesboro, where it occurs with the shell perfectly preserved. Morton's original illustration of the species from Alabama is very imperfect, but the Swedesboro specimens do not differ in any essential respect from the specimens illustrated by Conrad and Gabb from Eufaula, Alabama. Whitfield's species *T. mortoni,* described from internal casts and a single very imperfect external impression, is doubtless identical with this Swedesboro and southern species.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177); Wenonah sand, near Crawfords Corner (126[3]); Navesink marl, Atlantic Highlands (108), Freehold, Holmdel (Whitfield).

Geographic distribution.—New Jersey, Alabama, Mississippi, Arkansas, Texas.

Trigonia eufaulensis Gabb.

Plate XLVIII., Figs. 5–10.

1860. *Trigonia Eufalensis* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 396, pl. 68, fig. 32.

1861. *Trigonia Eufalensis* Gabb, Synop. Moll. Cret. Form., p. 232 (176).

1864. *Trigonia Eufalensis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 9.

1868. *Trigonia Eufalensis* Con., Cook's Geol. N. J., p. 725.
1886. *Trigonia Eufaulensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 113, pl. 14, figs. 1-4.
1905. *Trigonia eufalensis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 11.

Description.—Shell small, the dimensions of an average specimen being: length, 21 mm.; height 15 mm.; convexity, 4 mm. The largest specimen observed is under 30 mm. in length. Ovate subtrigonal in outline, somewhat alate posteriorly, moderately convex in front, compressed behind. Beaks almost anterior, slightly recurved. Anterior and antero-basal margin broadly rounded, postero-basal margin nearly straight, sloping upward towards the posterior hinge extremity, posterior extremity rounding sharply into the dorsal margin; dorsal margin nearly straight behind, becoming more strongly concave as it approaches the beak. Surface of the valves divided into two portions by a ridge passing with a concave curve from the posterior side of the beak to the posterior margin of the shell just below the posterior extremity of the hinge-line. The lower portion of the valve is marked by 12 or 14 strong, angular, non-nodose ridges, narrower than the interspaces, the more anterior ones of which curve strongly forward in passing from the bounding ridge to the shell margin, the more posterior ones becoming straighter, in some cases having a slightly sigmoidal curve. The upper portion of the shell is inflected above the bounding ridge for about one-half the distance to the hinge-margin, above which it is again deflected into nearly a plane with the valve, the ribs of the lower portion of the shell are continued across the upper portion, being abruptly bent backwards in crossing the bounding ridge, the more posterior ones being more strongly bent than those in front. Besides the ribs, the shell is marked by inconspicuous lines of growth.

Remarks.—This species usually occurs in the New Jersey formations in the form of more or less indefinite internal casts, but occasionally in certain hard nodules good impressions of the exterior are preserved, from which casts may be taken to show the external characters. It has been from such casts that the

above description has been made. Whitfield's material from which he illustrated the species was much more incomplete than that now available, some of his figures are more or less restored, and none of them represent the characters of the species as ordinarily preserved in the New Jersey faunas. The internal casts do not preserve the characters of the upper portion of the shell which are really the most essential specific features, but the presence of the keel-like extension of the shell along the hinge-line, rather than a sharply inflected border to form a broad escutcheon, can usually be recognized.

The impression from which Whitfield took the cast used to illustrate *Gouldia paralis* Con., is quite certainly the impression of a portion of a *Trigonia* shell, probably a member of this species.

Formation and locality.—Merchantville clay-marl, near Matawan (101), Lenola (163); Woodbury clay, near Matawan (103), near Haddonfield (183); Wenonah sand, near Marlboro (130), near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey, Alabama, Mississippi, Texas.

Trigonia cerulia Whitfield.

Plate XLVIII., Fig. 13.

1886. *Trigonia cerulia* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 114, pl. 14, fig. 7.

Description.—Shell small, the dimensions of an averaged sized left valve being: length, 30 mm.; height, 24.5 mm.; convexity, 9 mm. Subovate in outline, the beaks nearly anterior, obtuse, scarcely recurved. Anterior and ventral margins together forming nearly a semicircle, posterior margin rather sharply rounded above into the dorsal margin; dorsal margin gently concave from the beak to the posterior extremity of the hinge-line. Surface of the valve divided into two portions by an obscure ridge, subparallel with the dorsal margin, passing from the posterior side of the beak, with a gently concave curvature to the posterior mar-

gin a short distance below the posterior extremity of the hinge-line. The lower portion of the shell, which comprises the greater part of the surface, is covered with sharply angular and faintly crenulate ribs which curve strongly forward in front, the more posterior ones passing in a nearly straight line from the bounding ridge above to the basal margin, the interspaces between these ribs are broad in front becoming regularly narrower towards the posterior portion of the shell. The upper portion of the surface is divided longitudinally by a shallow groove along the lower side of which the ribs of the lower portion of the shell originate; they pass obliquely backward from their point of origin, bending more or less abruptly downward as they cross the bounding ridge; above the longitudinal furrow the surface is continuous for a short distance with the general surface of the valve and is then abruptly inflected to the hinge-line to form a rather broad escutcheon; from the upper margin of the longitudinal furrow a series of about 10 obscure ribs originates, which are directed obliquely backwards and continue in that direction to the margin of the inflected portion of the shell when they bend abruptly forward, becoming much stronger and continuing to the hinge-line which they meet in nearly right angles. Besides the ribs the surface of the shell is covered with obscure concentric lines of growth.

Remarks.—Whitfield's illustration and description of this species are misleading. The type specimen is very imperfect and has the surface much injured, the illustration being greatly restored. According to the original description there is no differentiation of the upper portion of the shell, but a little further development of the type specimen has shown the surface features to be as has been described above. The species is a common one in its type locality at Beers Hill cut, south of Keyport, and the recent collections of the Survey contain many specimens which show the essential features of the shell far better than the type.

Formation and locality.—Tinton beds, Beers Hill cut, south of Keyport (129^5, 129^7, 129^9), near Freehold (132).

Geographic distribution.—New Jersey.

Trigonia kümmeli n. sp.

Plate XLVIII., Figs. 11–12.

Description.—Shell small, the dimensions of an average specimen being: length about 26 mm.; height, 20 mm.; convexity, 6 mm. Ovate-subtrigonal in outline, moderately convex in front, the greatest convexity being near the anterior margin, compressed posteriorly. Beaks rather sharp, nearly anterior, slightly recurved. Anterior and antero-basal margin describing nearly a semicircle; postero-basal margin straighter and sloping upward towards the posterior hinge extremity; dorsal margin gently concave. Surface of the valves divided into two regions by a ridge, or more properly by a row of nodes passing in a concave line from the posterior side of the beak to the posterior margin a little below the hinge extremity. The lower portion of the valve marked by 14 or 15 sharply angular, prominent, narrow, nodose ribs, the most anterior ones of which curve strongly forward in passing from the dorsal extremity to the shell margin; the first two or three ribs on the beak are crowded close together, the interspaces gradually becoming broader to about the sixth rib, beyond which the interspaces are about equal in width, being much wider than the ribs themselves. The upper surface of the valve continues in the general slope of the valve from the row of bounding nodes to over half the distance to the hinge-line, the surface is then sharply inflected for a short distance and then again deflected, when it continues to the hinge margin in nearly the plane of the valve, this deflected portion of the two valves forming a keel-like projection of the shell along the hinge-line back of the beaks. The ribs of the lower portion of the shell are bent abruptly forward as they cross the bounding line between the two portions of the valve; they continue in that direction to about the middle of the broad, inferior part of the upper portion, when they are bent abruptly backward to the lower margin of the inflected portion, where they are again bent forward to the hinge margin; towards the posterior extremity of the shell the ribs become more or less indistinct. In addition to the ribs the shell is marked by concentric lines of growth, which are indistinct except in front near the margin.

Remarks.—This species resembles *T. eufaulensis* in general form and proportions, and in the keel-like extension of the shell along the hinge-line back of the beak. From the internal casts alone the two species can hardly be distinguished if at all, but the external characters of the shell are quite different. The ribs of the shell of *T. kümmeli* are narrower, sharper and nodose, and the interspaces between the ribs continue to the posterior portion of the shell with about the same width, while in *T. eufaulensis* the interspaces become regularly narrower posteriorly. The zig-zag direction of the ribs across the upper portion of the shell is also different from *T. eufaulensis*, in which species they pass directly across this portion of the shell from the bounding ridge below to the hinge-line.

Formation and locality.—Red Bank sand, Red Bank (116), near Middletown (112), Shrewsbury River (119).

Geographic distribution.—New Jersey.

Super-family PECTINACEA.

Family PECTINIDAE.

Genus PECTEN Müller.

Pecten tenuitestus Gabb.

Plate L., Fig. 9.

1861. *Pecten tenuitesta* Gabb, Proc. Acad. Nat. Sci. Phil., 1861, p. 327.
1864. *Pecten tenuitesta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 7.
1868. *Pecten tenuitesta* Con., Cook's Geol. N. J., p. 725.
1886. *Pecten planicostatus* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 48, pl. 8, figs. 10-11.
1905. *Pecten tenuitesta* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 11.

Description.—Left valve depressed convex or nearly flat, equilateral, and aside from the auriculations nearly subcircular in out-

line. The dimensions of an imperfect impression of a left valve are: height, about 40 mm.; width, 41.5 mm.; length of hinge-line, about 22 mm. Auriculations of moderate size, subequal, but slightly depressed below the general surface. Surface marked by about thirty, low, rounded ribs, which are much narrower than the flattened interspaces, the stronger ribs continue to the beak and never bifurcate, the smaller ones being added by intercalation, the auriculations are entirely free from radiating ribs; besides the radiating ribs the entire surface is marked by exceedingly fine, regular, concentric striæ. The shell substance is apparently very thin.

Remarks.—Whitfield is in error in his identification of *Pecten tenuitestus* Gabb, as has been shown by a study of the type specimens in the collection of the Philadelphia Academy of Science, the species being described as a new form by him under the name *P. planicostatus*. The shells which Whitfield has referred to *P. tenuitestus* are quite a distinct form, however, and will need to receive a new name as they are apparently undescribed; this species is called *P. whitfieldi* in the present report. The true *P. tenuitestus* differs from *P. whitfieldi* in its more nearly subcircular outline, the less compressed auriculations, the non-nodose radiating ribs, and in the character of the fine concentric striæ.

Formation and locality.—Navesink marl, near Freehold (133), Crosswicks Creek (147^4, 149), near Marlboro (Whitfield).

Geographic distribution.—New Jersey.

Pecten whitfieldi n. sp.

Plate L., Fig. 14.

1886. *Pecten tenuitestus* Whitfield, Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 47, pl. 7, figs. 5-6.

Description.—Shell, exclusive of the auriculations, broadly ovate in outline, higher than wide, the dimensions of a left valve being: height, 40 mm.; width, 35 mm.; convexity, 5 mm.; length of hinge-line about 16 mm. Left valve depressed convex, deepest above the middle, the beak pointed, auriculations

of moderate size, the anterior one larger than the posterior. Surface marked by low, rounded, nodose, more or less unequal, radiating ribs, which increase by intercalation, 30 or more are present upon the body of the shell where they are narrower than the interspaces, the ribs upon the auriculations are narrower, closer together, and more nodose than upon the body of the shell, though in some examples, especially the larger ones, they are inconspicuous. The surface is also marked by more or less irregular, concentric lines of growth.

Remarks.—The shells which are made the types of this species were identified and illustrated by Whitfield as *P. tenuitestus*, but an examination of Gabb's type of that species has shown that Whitfield's identification was incorrect, the true *P. tenuitestus* being the same as the specimens described as *P. planicostatus* by that author. This species differs from *P. tenuitestus* of the same fauna, in being proportionally higher, narrower, and more convex, with the radiating ribs nodose, and proportionally broader with narrower interspaces and with the concentric markings coarser and less regular.

Formation and locality.—Navesink marl, Crosswicks Creek (149, 147[3], 195), near Jacobstown (150), Holmdel and near Marlboro (Whitfield).

Geographic distribution.—New Jersey.

Pecten cliffwoodensis n. sp.

Plate L., Figs. 7–8.

Description.—The dimensions of an average specimen, a left valve, are: height, 30 mm.; width, 27.5 mm.; convexity, 4 mm.; length of hinge-line, 14 mm. The body of the shell broadly subovate in outline, the beaks situated a little back of the middle of the hinge-line, the auriculations moderately large and sharply differentiated, the anterior ones somewhat larger than the posterior, the cardinal slopes diverging from the beak at an angle of 90° or a little more, nearly straight or slightly concave, terminating at the sides of the shell above the middle of its height. The valves subequally depressed convex, the right valve if anything slightly flatter than the left, with a moderately deep byssal

sinus. Surface of both valves nearly smooth, marked only by fine concentric lines of growth which continue across the auriculations, and on the anterior ear of the right valve become stronger than elsewhere on the shell.

Remarks.—One imperfect specimen which seems to be a member of this species, had a height when complete of about 50 mm., but the dimensions given above are those of a specimen of about average size. Some of the smaller individuals do not exceed 12 mm. in height. With the growth of the shell the proportionate width seems to increase. This species is unlike any of the other Pectens in these New Jersey faunas, but in general form and size the shells most closely resemble some individuals of *Pecten bellisculptus* Con.; the two species can always be distinguished, however, by their surface markings.

Formation and locality.—Cliffwood clay, Cliffwood Point (105), near Matawan (107, 189).

Geographic distribution.—New Jersey.

Pecten burlingtonensis Gabb.

Plate XLIX., Figs. 5–9.

1860. *Pecten burlingtonensis* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 304, pl. 48, fig. 25.

1861. *Pecten burlingtonensis* Gabb, Synop. Moll. Cret. Form., p. 213 (151).

1864. *Pecten burlingtonensis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 7.

1868. *Syncyclonema burlingtonensis* Con., Cook's Geol. N. J., p. 725.

1870. *Camptonectes burlingtonensis* Con., Am. Jour. Conch., vol. 6, p. 76.

1876. *Camptonectes Burlingtonensis* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 318.

1886. *Camptonectes* (*Amusium*) *burlingtonensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 53, pl. 8, figs. 7 ? and 8 (not 3-6 and 9=*P. argillensis* Con.).

1886. *Pecten* (*Syncyclonema* ?) *perlamellosus* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 50, pl. 7, fig. 7.

1905. *Pecten burlingtonensis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 11.

1905. *Pecten perlamellosus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.

Description.—Shell, in large individuals, attaining a height of 57 mm., and a width of 62 mm.; the hinge-line straight, one-half or a little less than one-half the width of the shell, with a central triangular cartilage pit; the body of the shell broadly subovate in outline, the auriculations moderately large and nearly equal in size; the cardinal slopes a little concave, diverging from the beak at an angle of 90° or more, the shoulders of the valves prominent and above the middle of the height of the shell. Left valve depressed convex with the auriculations sharply differentiated. Right valve nearly flat, with a moderately deep byssal sinus. Surface of the valves marked by concentric bands which are continuous across the auriculations, and by exceedingly fine, impressed, radiating striæ which are continuous upon the auriculations and the umbo, where they are about equal in width with the interspaces, but on the outer portion of the shell they become more or less discontinuous, the inner portion of the concentric bands often being nearly smooth, while on the outer portion they are completely striate, but with the interspaces between the striæ broader than the striæ themselves.

Remarks.—Whitfield has united *Pecten bellisculptus* Con., with *Pecten burlingtonensis* Gabb, but an examination of a large number of individuals in the recent collections of the Survey show the two species to be entirely distinct. The two forms have sometimes been considered as the opposite valves of the same species, but this cannot be so for one example of *P. burlingtonensis* has been examined which preserves the cast of both valves, and they do not essentially differ in the character of the markings although the right valve is much flatter than the left. In the present report *P. bellisculptus* is considered as synonymous with *P. argillensis.*

The surface markings, even in internal casts, are usually sufficient to separate the two forms, the conspicuous feature of *burlingtonensis* being the concentric bands, the radiating striæ usually being entirely wanting in the casts, while in *argillensis* the

radiating markings are the conspicuous feature of the shell and can be detected upon the casts as preserved in New Jersey, as well as upon the shells themselves or the impressions of the exterior. The nearly flat right valve and the nearly equal size of the auriculations are other characters distinguishing *burlingtonensis*. This species is also never so high and narrow proportionally as *argillensis*, although some members of the latter species sometimes have nearly the same proportions as specimens of *burlingtonensis*. The two species occur together in both the Merchantville and the Woodbury formations, but *burlingtonensis* is more common in the Merchantville, while *argillensis* is the commoner species in the Woodbury, but wherever they occur there is not the least difficulty in separating them. Gabb's type specimen was from the Merchantville. Whitfield's figure 7 seems to be a member of this species with one ear injured, but its identity cannot be determined from the figure alone. *Pecten perlamellosus* Whit. is apparently only an immature example of *P. burlingtonensis*, these young individuals being closely similar to *P. conradi* except that the concentric bands are somewhat broader and continue in nearly full strength across the auriculations.

Formation and locality.—Merchantville clay-marl, near Matawan (101), near Jamesburg (141), Lenola (163), Burlington (Gabb); Woodbury clay, Lorillard (102), near Haddonfield (183); Wenonah sand, near Marlboro (130).

Geographic distribution.—New Jersey.

Pecten argillensis Conrad.

Plate XLIX., Figs. 1–4.

1860. *Pecten argillensis* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 283.

1861. *Pecten argillensis* Gabb, Synop. Moll. Cret. Form., p. 213 (157).

1864. *Pecten argillensis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 7.

1869. *Camptonectes bellisculptus* Con., Am. Jour. Conch., vol. 5, p. 99, pl. 9, fig. 11.

1886. *Camptonectes* (*Amusium*) *Burlingtonensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 53, pl. 8, figs. 3-6, 9 (not 7-8).

1905. *Pecten bellisculptus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 11.

Description.—Shell, in large individuals, attaining a height of 35 mm. to 40 mm., and a width of 30 mm. to 36 mm., the height usually considerably greater than the width, but the two dimensions nearly equal in some individuals; hinge-line straight, one-half or less than one-half the width of the shell, the beaks situated back of the middle point of the hinge; the body of the shell subovate in outline, the auriculations sharply differentiated, unequal, the anterior ones being much broader than the posterior; cardinal slopes usually a little concave, diverging from the beaks at an angle of 90° or less. Right valve depressed convex with a rather deep byssal sinus in front; left valve more strongly convex. Surface of both valves marked by fine, even radiating ribs with much narrower interspaces; by reason of their frequent bifurcation the ribs maintain essentially the same size throughout and at the sides of the valves they curve strongly upward in the upper portion, crossing the cardinal slopes and continuing across the auriculations. Besides the radiating ribs the shells are marked by rather close, concentric raised lines which project slightly as they cross the radiating ribs, and which towards the front of the shell sometimes form fine spines.

Remarks.—A comparison of the New Jersey specimens of *Pecten bellisculptus* with authentic examples of *Pecten argillensis* from Mississippi in the collections of the National Museum at Washington, has failed to disclose any characters which can be considered as of specific value. The only character in which examples from the two localities differ in any noticeable degree is in the strength of the radiating markings of the shell, the southern specimens perhaps having these markings slightly coarser. In the present report the specimens from the two regions are united in a single species to which the prior name *P. argillensis* is given. This species, however, is quite distinct from *Pecten burlingtonensis* with which Whitfield united it; it does not grow so

large as that species and its surface markings are quite distinct as has already been pointed out under the discussion of that species. The species is more typically represented in the fauna of the Woodbury clay, from which formation, near Haddonfield, Conrad's type specimens were obtained, but it also occurs in the Merchantville clay-marl and in the Navesink marl. The Woodbury specimens seem always to be proportionately higher and narrower than *P. burlingtonensis,* but in the Merchantville and Navesink formations, individuals are not infrequently met with having nearly the proportions of that species; they can always be distinguished, however, by their surface markings and by the less nearly equal size of the auriculations. It is possible that these rounder, Merchantville and Navesink specimens should be separated as a distinct species, characterized not only by their different form, but also by the larger size which they often attain.

Formation and locality.—Merchantville clay-marl, near Matawan (101), near Jamesburg (139), Lenola (163); Woodbury clay, Lorillard (102), Haddonfield (183); Marshalltown clay-marl, near Swedesboro (179); Wenonah sand, near Marlboro (130); Navesink marl, Crosswicks Creek (149, 147[4]), Freehold (Whitfield).

Geographic distribution.—New Jersey, Mississippi, Texas.

Pecten conradi (Whitfield).

Plate L., Figs. 1–4.

1868. *Pecten simplicus* Con., Cook's Geol. N. J., p. 725 (not *Pecten simplicius* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, pp. 283-284, pl. 46, fig. 44.)

1869. *Sinsyclonema ? simplica* Con., Am. Jour. Conch., vol. 5, p. 99, pl. 9, fig. 20.

1886. *Amusium Conradi* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 52, pl. 7, figs. 8-10.

1905. *Pecten conradi* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.

Description.—"Shell small, seldom exceeding half an inch in height; erect-ovate, becoming more elongate proportionally with

increased growth. Valves slightly convex. Hinge short, from half to two-thirds as long as the width of the body of the shell, strongly and distinctly auriculated. Beaks of the valves small and pointed, and the cardinal slopes long, straight or slightly concave, extending to near the point of greatest width of the body of the shell. Left valve smooth or but faintly marked by fine concentric lines, and a few (five or six) very faint radii. Ears smaller than in the opposite valve, both sloping toward the beak on the outer margin. Right valve marked with crowded concentric folds or elevated lines; also by five or six radiating lines; not always present. On most specimens there are distinctly rounded concentric folds or varices, but on some they are thin, sharp lines; always more crowded and usually finer toward the front, in adult specimens. Ears very distinct; that of the posterior side sloping toward the beak and the anterior one rounded at the extremity and deeply notched." (Whitfield.)

Remarks.—This species is not uncommon in both the Merchantville and Woodbury formations. It is especially abundant in the Woodbury at Lorillard, but, like so many of the species from that locality, it grows to a much larger size than elsewhere; the average size of the individuals from there is not far from 15 mm. in height, while the largest ones are 17 mm. or more. The types of the species illustrated by Whitfield are 9 and 10 mm. in height, and he states that it seldom exceeds "half an inch in height" (12.5 mm.); the specimens from other localities than Lorillard agree with this statement. As noted by Whitfield, the species is a close ally of *Pecten simplicum* Con., and the New Jersey specimens have frequently been identified with that species. It differs especially from that species, however, in the conspicuous concentric markings which are always present upon the left valve at least. The larger specimens of the species from Lorillard somewhat resemble the young of *Pecten burlingtonensis* Gabb, but the concentric bands are narrower and do not continue across the auriculations as in that species.

Formation and locality.—Merchantville clay-marl, near Matawan (101), near Jamesburg (139, 141), Merchantville (162), Lenola (163); Woodbury clay, Lorillard (102), near Matawan

(103), Crosswicks (168), near Haddonfield (164, 168, 183); Navesink marl (rare), near Crawfords Corner (126[7]), Mullica Hill (169).

Geographic distribution.—New Jersey.

Pecten quinquenaria Conrad.

Plate L., Figs. 10–13.

1853. *Pecten quinquenaria* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 275, pl. 24, fig. 10.

1861. *Neithea quinquenaria* Gabb, Synop. Moll. Cret. Form., p. 204 (148).

1864. *Neithea quinquenaria* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 7.

1886. *Pecten quinquenarius* Whitf., Pal. N. J., vol 1 (Monog. U. S. G. S., vol. 9), p. 47, pl. 7, figs. 13-16.

1905. *Pecten quinquenaria* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 11.

Description.—"Shell of medium size, slightly oval transversely; in outline a little wider than high. Valves plano-convex in profile when united. Hinge line much shorter than the width of the shell below. Ears large, slightly unequal; that of the flat valve (right) somewhat sinuate on the anterior side. Cardinal slope of the valves somewhat concave between the beaks and the lateral margins of the body of the shell. Surface of the valves marked by strong, wide, rounded, radiating ribs, about five on the flat valve and six on the convex valve. On the convex valve, as shown upon the impression left in the fine blue marl, there have been fine, even, and closely arranged concentric lines crossing the folds and passing up over the auriculations; in fact, covering the entire surface of the valve. The opposite flat valve has not been marked by concentric lines, as was the convex valve, the surface of the cast, both inside and outside impressions, being apparently smooth. No remains of radiating lines on the folds can be seen." (Whitfield.)

Remarks.—This species occurs in abundance in the Wenonah sand just beneath the base of the Navesink marl at a locality near Marlboro. Whitfield reports the species from the base of

the Navesink in G. C. Schanck's pits near Marlboro, a locality less than one-fourth of a mile from that which has furnished the Survey material. The species has been detected at but one locality in the Navesink, in the recent collections of the Survey. It is probable that Whitfield's specimens were from the top of the Wenonah rather than from the base of the Navesink, since the Wenonah was exposed in the marl pits mentioned, and many species were described from that horizon at that locality are now known to belong in the Wenonah fauna.

Formation and locality.—Wenonah sand, near Marlboro (130); Navesink marl, near Red Bank (120).

Geographic distribution.—New Jersey, Mississippi.

Pecten parvus (Whitfield).

Plate L., Figs. 5–6.

1886. *Camptonectes parvus* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 55, pl. 8, figs. 1-2.

Description.—"Shell quite small, the only specimen observed measuring only about three-tenths of an inch in height. Outline subcircular and (the left valve) convex, moderately elevated on the umbo and somewhat regularly declining in convexity, toward the front; anterior auriculation proportionally large and vertically striated with lamellose striæ parallel to the anterior margin. Surface of the shell polished and marked with numerous interrupted impressed striæ, the spaces between the striæ being flattened and crossed by very faint lines of growth." (Whitfield.)

Remarks.—Whitfield reports having seen but a single specimen of this small species, and no further examples have come to light in the more recent collections of the survey. The type is probably from some portion of the Navesink marl, although the horizon cannot be determined with any great degree of certainty.

Formation and locality.—Navesink marl ?, Freehold (Whitfield).

Geographic distribution.—New Jersey.

Pecten craticulus Morton.

Plate L., Figs. 15–16.

1833. *Pecten craticula* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 293.
1834. *Pecten craticula* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 57.
1861. *Pecten craticula* Gabb, Synop. Moll. Cret. Form., p. 214 (158).
1864. *Pecten craticula* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 7.
1868. *Pecten craticula* Con. Cook's Geol. N. J., p. 725.
1886. *Pecten (Chlamys) craticulus* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 49, pl. 7, figs. 17–18.
1905. *Pecten craticula* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 11.

Remarks.—This species was described by Morton from a fragment of a shell said to have been collected by Conrad at Arneytown, New Jersey. The type specimen was illustrated by Whitfield, but the species has not been met with in the recent collections of the Survey. If the recorded locality of the species is correct it probably came from the Navesink marl. Whitfield also mentions having seen similar fragments labeled Vincentown, New Jersey, which, if the identification and locality are correct, would indicate a much higher horizon.

Formation and locality.—Navesink marl ?, Arneytown (Morton).

Geographic distribution.—New Jersey.

Pecten venustus Morton.

Plate LI., Figs. 1–5.

1833. *Pecten venustus* Morton, Am. Jour. Sci., 1st ser., vol. 23, p. 293, pl. 5, fig. 7.
1834. *Pecten venustus* Morton, Synop. Org. Rem. Cret. Gr. U. S., p. 58, pl. 5, fig. 7.

1861. *Pecten venustus* Gabb, Synop. Moll. Cret. Form., p. 217 (161).
1864. *Pecten venustus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 7.
1868. *Pecten venustus* Con., Cook's Geol. N. J., p. 725.
1886. *Pecten venustus* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 45, pl. 7, figs. 1-2.
1905. *Pecten venustus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 11.

Description.—"Shell quite small, seldom attaining a height of more than five-eighths of an inch, and not commonly of more than half an inch. Form nearly circular below the ears and a little straightened on the cardinal slopes. Valves convex, slightly inequivalve and erect, or not perceptibly inequilateral. Cardinal line about half as long as the greatest width of the valves, which is a very trifle less than the height. Auriculations very unequal, distinctly separated from the body of the shell. The posterior one is quite small and alike in each valve; anterior large, ribbed on each valve, and provided with a moderately distinct notch below in the right one. Right valve most convex, marked by 17 to 19 elevated radiating ribs, which are somewhat flattened on the top and are marked by fine transverse striæ. Interspaces narrow and deep. Many of the ribs of this valve become duplicate below the middle of the valve. Left valve depressed, convex, with narrow, sharply-elevated ribs, which are separated by much wider interspaces, and are marked by comparatively distant elevated rugæ. Many of the wider interspaces have a thinner and smaller rib along their middle below the center of the valve, corresponding to the duplicated ribs of the opposite valve.

On the interior of the valves the ribs are distinctly marked, but much more strongly so along the margin of the shell. Cardinal line marked by a single ridge on each side of the center nearly parallel to the hinge-line in the left valve, with corresponding grooves in the right. Ligamental pit well marked." (Whitfield.)

Remarks.—This is one of the smaller species of *Pecten* recognized in the Cretaceous faunas of New Jersey, and is a common

member of the Navesink and Red Bank faunas. Whitfield mentions Burlington as one of the localities for the species, which would indicate a lower horizon, but it has not been met with in the recent collections of the Survey anywhere below the Navesink except one occurrence in the Marshalltown. It is quite probable that the locality recorded with Whitfield's Burlington specimen was intended for Burlington County, as many specimens in the Philadelphia Academy collections are so labeled, and in that case the specimen doubtless came from the Navesink.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (179); Navesink marl, near Walnford (149), near Crawfords Corners (126[7]), near Holmdel (128[3], 127), Marlboro (131), near Freehold (133), Crosswicks Creek (149, 195), Mullica Hill (169); Red Bank Sand, Red Bank (116, 123), Shrewsbury River (119); Tinton beds, Tinton Falls (110), Beers Hill cut (129[5]), near Freehold (132).

Geographic distribution.—New Jersey.

Pecten simplicius Conrad.

Plate LI., Fig. 6.

1860. *Pecten simplicius* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 283, pl. 46, fig. 44.
1861. *Pecten simplicius* Gabb, Synop. Moll. Cret. Form., p. 216 (160).
1864. *Sincyclonema ? simplicus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 7.
1868. *Pecten simplicus* Con., Cook's Geol. N. J., p. 725.
1876. *Sincyclonema simplicius* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 319.
1886. *Amusium simplicum* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 51, pl. 7, figs. 11-12.

Description.—"Shell small, barely half an inch in extreme height, and of equal width; discoid or very depressed convex, nearly or quite equilateral; margins of the shell somewhat regularly rounded; hinge-line a little less than half the width of the shell, and slightly rising from the center toward the extremities. Auriculations moderately large, the anterior side largest,

slightly rounded on the outer margin and forming a slight byssal notch at its junction with the body of the shell on the right valve. Cardinal slopes on the right valve straight to near the point of greatest width of the valve, and forming an angle of about fifty to fifty-five degrees with each other and very strongly impressed. Beak small and pointed. On the left valve the posterior ear is the smallest of the two, and the cardinal slopes less strongly marked, not so straight, and extend down the valve not so far as on the opposite valve. Surface of the valves smooth and shining to the naked eye, but under a lens is seen to be marked by fine concentric lines of growth, and on the left valve by faint, incipient, radiating lines." (Whitfield.)

Remarks.—Whitfield's description quoted above, is drawn from Alabama specimens of this species, all the New Jersey material at his disposal being "too imperfect for illustration." The species is also extremely rare in the more recent collections of the Survey, nearly all the shells of this type being marked with conspicuous concentric lines, which have been made the chief characteristics of the species *Pecten conradi* Whitf. A few individuals of a small *Pecten* from the Tinton beds, however, the largest of which does not exceed 10 mm. in height, seem to be characterized in the impressions of the external surface, by their perfectly smooth shells, and have been identified with Conrad's species.

Formation and locality.—Red Bank sand, near Middletown (112), Tinton beds, Tinton Falls (110), Beers Hill cut (129^5), near Freehold (132).

Geographic distribution.—New Jersey, Alabama, Mississippi, Arkansas, Texas.

Genus NEITHEA Drouet.

Neithea quinquecostata (Sowerby).

Plate LI., Figs. 7–12.

1814. *Pecten quinquecostata* Sow., Min. Conch., vol. 1, p. 122, pl. 56, figs. 4-8.

1830. *Pecten quinquecostatus* Morton, Am. Jour. Sci., 1st ser., vol. 17, p. 285, vol. 18, pl. 3, fig. 5.

1834. *Pecten quinquecostatus* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 57, pl. 19, fig. 1.
1838. *Pecten quinquecostatus* Bronn, Lethaea Geog., Zweiter Band, pp. 678-680, taf. 30, fig. 17.
1849. *Pecten quadricostatus* Roem., Texas, p. 398.
1850. *Janira mortonii* d'Orb., Prod. Paleon. Strat., vol. 2, p. 253.
1852. *Pecten quadricostatus* Roem., Kreide von Texas, p. 64.
1852. *Pecten quadricostatus* var. Roem., Kreide von Texas, p. 64, pl. 8, figs. 4 a-c.
1854. *Pecten quadricostatus* Shum., Marcy's Expl. Red River La., p. 178, pl. 2, figs. 2 a-b, pl. 3, fig. 6.
1861. *Neithea mortonii* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 365.
1861. *Neithea mortonii* Gabb, Synop. Moll. Cret. Form., p. 188 (132).
1864. *Neithea mortoni* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 7.
1868. *Neithea mortoni* Con., Cook's Geol. N. J., p. 725.
1870. *Pecten quadricostatus* Credner, Zeitsch. Deutsch. Geol. Ges., Bd. 22, p. 232.
1886. *Neithea quinquecostata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 56, pl. 8, figs. 12-14.

Description.—"Shell broadly ovate exclusive of the auriculations, and plano-convex to concavo-convex in profile, right valve strongly convex, with a sharp, arching, and incurved beak extending beyond and partially overarching the hinge-line; hinge-line straight or nearly so, slightly declining on the anterior side; nearly two-thirds as long as the entire width of the shell; auriculations moderate in size, the anterior one the smallest and constricted below where it joins the body of the shell, forming a slight byssal notch; posterior side triangular, longest at the hinge-line and receding below. Sides of the valve where it joins the auriculations strongly incurved laterally, so as to cause the sides to overhang. Valve marked by six strong, rounded, principal radiating costæ, with from two to four smaller ones be-

tween. These are usually distributed in the following manner: three between the two anterior strong ones; three or four between the two antero-basal and median ones; three usually between the postero-basal pair, and usually two only between the posterior pair. There are also three or four anterior to the first strong ray, and from four to six on the area posterior to the last principal ray. The auriculations are also rayed, unequally on the opposite sides, the posterior one most strongly. The characters of the flat or left valve have not been observed on the New Jersey specimens. The casts, the only condition in which I have seen them from within the State, show evidence of moderately strong concentric lines crossing the rays and intermediate portions of the shell." (Whitfield.)

Remarks.—The secondary ribs between the six larger ones shows considerable variation in the different individuals of this species, but Whitfield was doubtless correct in his reference of all the specimens to a single species. In 1850 D'Orbigny proposed the specific name *mortoni* for this American form and was followed by several authors, but that species seems to have been founded upon insufficient characters, and in this place we follow Whitfield in considering the American specimens to be identical with the common European one.

The species occurs at various horizons in the New Jersey Cretaceous, but is especially abundant in the Marshalltown clay-marl near Swedesboro, where excellent specimens with the shells preserved occur. The shells do not grow so large, however, in the Swedesboro locality, as the example illustrated by Whitfield, it being a rare occurrence to collect a shell exceeding 40 mm. in length. Some incomplete specimens of the flat valve from the Navesink marl on Crosswicks Creek north of New Egypt, however, must have been fully as large as the larger specimen illustrated by Whitfield, 65 mm. in length. The Merchantville clay-marl specimens more nearly agree with the Swedesboro specimens in size.

Formation and locality.—Merchantville clay-marl, near Matawan (101), Lenola (163), Burlington (Whitfield); Marshalltown clay-marl, near Swedesboro (177, 179, 180); Navesink

marl, Atlantic Highlands (108), Crosswicks Creek (147), Mullica Hill (169), Holmdel and Freehold (Whitfield).

Geographic distribution.—New Jersey, Alabama, Mississippi, Texas.

Family SPONDYLIDAE.

Genus PLICATULA Lamark.

Plicatula urticosa (Morton).

Plate LII., Figs. 1–2.

1833. *Ostrea urticosa* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 293, vol. 24, pl. 10, fig. 2.
1834. *Plicatula urticosa* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 62, pl. 10, fig. 2.
1861. *Plicatula urticosa* Gabb, Synop. Moll. Cret. Form., p. 225 (169).
1864. *Plicatula urticosa* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 7.
1868. *Plicatula urticosa* Con., Cook's Geol. N. J., p. 724.
1886. *Plicatula urticosa* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 61, pl. 9, figs. 1–2.
1905. *Plicatula urticosa* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.

Description.—"Shell irregularly oval in outline and obliquely curved, biconvex or plano-convex, marked by strong, somewhat angular radiating and bifurcating plications, usually much stronger and less numerous on the lower than on the upper valve, and crossed by strong projecting concentric lamella, which are elevated and often form thin, flat spines on the crest of the radiating plications of greater or less length, which give a very rough and spiney surface to the shell, resembling that of *Spondylus*. Muscular impression moderate; teeth not observed." (Whitfield.)

Remarks.—This species has not been met with abundantly in the recent collections of the Survey. It differs from that form described in the present report as *P. mullicanensis* in its more irregular form and in its much more rugose markings.

Formation and locality.—Navesink marl, near Walnford (148[1], 148[2]), Holmdel and Freehold (Whitfield).

Geographic distribution.—New Jersey.

Plicatula mullicaensis n. sp.

Plate LII., Figs. 3–5.

Description.—Shell obliquely ovate. The upper valve depressed-convex, marked by radiating costæ and concentric lines of growth, at the junction of which the radiating costæ are produced into short spines.

The dimensions of an average specimen are: total length, 30 mm.; width, 22 mm.

Remarks.—This species is abundant at Mullica Hill and has usually been identified as *P. urticosa*. It differs from that species, however, in its much more regular outline and in its much finer surface markings. Only the upper valves of the species have been observed, but these seem to be more uniform in their characters than is usual for members of this genus.

Formation and locality.—Navesink marl, Mullica Hill (169).

Geographic distribution.—New Jersey.

Plicatula woodburyensis n. sp.

Plate LII, Figs. 8–9.

Description.—Upper valve subovate in outline, only slightly oblique, moderately convex on the umbo, the remainder of the valve nearly flat. Marked by more or less alternating radiating costæ which are nearly obsolete upon the umbonal portion, becoming regularly stronger towards the margin, those in front and behind the umbo curving strongly upward, the costæ elevated at intervals into small, short spines directed at nearly right angles to the surface of the shell. Lower valve not known.

The dimensions of the type specimen are: height, 28.5 mm.; width, 26 mm.

Formation and locality.—Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey.

Genus SPONDYLUS Linneus.

Spondylus gregalis (Morton).

Plate LIII., Figs. 1–3.

1833. *Plagiostoma gregalis* Mort., Am. Jour. Sci. 1st ser., vol. 23, p. 292, pl. 5, fig. 6.
1834. *Plagiostoma gregale* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 60, pl. 5, fig. 6.
1861. *Spondylus gregalis* Gabb, Synop. Moll. Cret. Form., p. 227 (171).
1864. *Spondylus gregalis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 7.
1868. *Spondylus gregalis* Con., Cook's Geol. N. J., p. 724.
1886. *Spondylus gregalis* Whitf. Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 57, pl. 9, figs. 11-12, pl. 10, figs. 1-2.
1905. *Spondylus gregale* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.

Description.—"Shell rather above medium size when fully grown, and generally ovate in form, with the lower or attached valve somewhat the deepest. Cardinal area large, but short, much extended and flattened on the surface; transversely striated and with a narrow linear groove through the middle; teeth strong. Surface of the lower valve strongly lamellose on the free portions; the attachment apparently being only small and near the apex; between the lamella, which are elevated, the surface shows indistinct radiations, which on the interior are quite distinctly marked and flexuose, and are comparatively fine. The upper valve not observed, except as shown on casts of the interior. In this condition it is shown to have been only very moderately convex at the apical portions, and to have been flattened or but very slightly convex toward the front, with the surface radiated as in the case of the lower valve, but whether the exterior has been lamellose or only simply radiated I have not been able to ascertain." (Whitfield.)

The dimensions of the large lower valve figured by Whitfield are: length, 95 mm.; width, about 55 mm.

Remarks.—This species seems to be of rather rare occurrence as only fragments have been met with in the recent collections of the Survey. All the specimens on record seem to have come from the Navesink marl.

Formation and locality.—Navesink marl, near Crawfords Corners (126[7]), near Walnford (148[2]), Crosswicks Creek (195), Upper Freehold (Whitfield).

Geographic distribution.—New Jersey.

Genus Dianchora Sowerby.

Dianchora echinata (Morton).

Plate LIII., Figs. 4–6. Plate LIV., Figs. 1–2.

1835. *Plagiostoma echinatum* Mort., Synop. Org. Rem. Cret. Gr. U. S., Add. Obs., iv.
1853. *Spondylus capax* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 2, p. 274, pl. 24, fig. 8.
1864. *Spondylus echinatus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 7.
1868. *Spondylus echinatus* Con., Cook's Geol. N. J., p. 724.
1886. *Dianchora echinata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 59, pl. 10, figs 3–9.
1905. *Dianchora echinata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.

Description.—"Shell below medium size, subcircular or very broad-ovate in general outline, and with a very highly convex or gibbous free valve. Lower valve fixed to foreign substances, and often by nearly its entire surface, and conforming in depth to the surface to which it is affixed, or nearly so. Or when more concave the space between the margin of the shell and the object to which it is attached is filled up with shelly matter formed in the same manner as the spines of the valves. The cardinal portion of the valve is open, forming a broad triangular foramen the entire width of the valve at this point, the margins of the

foramen being sharp, no hinge-teeth or cardinal area existing. The interior of the valve is strongly marked by moderately fine striæ or ribs, which are flattened on their surfaces; muscular imprints not observable. Upper valve very ventricose and strongly arcuate, the beak thin and sharply incurved. Hinge open as in the lower valve, the cardinal angles spread outward in the form of auriculations to meet those of the opposite valve. The sides of the valve are sharply bent inward on a line from the beak to the point of greatest width, forming a hiatus on each side between the body of the valve and the auriculation, as in the genus *Janira*. Surface of the valve marked by strong, closely compact, radiating ribs; every fifth or sixth one of which is stronger than the others, and bears short, sharp, curved spines, some of which are nearly one-fourth of an inch long, while the others are only rugose from the concentric lamella which cross them. On the depressed spaces on the sides of the valve there are no radii, the concentric lines only being present. Substance of the shell thin in the cardinal portions and much thickened toward the front. Interior of the valve marked by the radii, and the thickened front margin strongly crenulate." (Whitfield.)

Remarks.—This species is a rare form restricted to the Navesink fauna, the lower valves usually being attached to the interior surface of the shells of *Gryphaea convexa*. At Mullica Hill the casts of this species have been observed more commonly than at any other locality. The upper free valve does not always have the larger, spine-bearing ribs so conspicuously developed as in the type of the species illustrated by Whitfield. In some specimens the ribs are of essentially uniform size throughout, and in others the larger ones are only moderately developed. The type specimen seems to be rather exceptional in its conspicuous development of the larger ribs.

Formation and locality.—Navesink marl, Middletown (113[2]), near Holmdel (128[3]), Mullica Hill (169), Holmdel and Freehold (Whitfield); Tinton beds, Tinton Falls (110).

Geographic distribution.—New Jersey.

Genus LIROSCAPHA Conrad.

Liroscapha squamosa Conrad.

Plate LII., Figs. 6-7.

1869. *Liroscapha squamosa* Con., Am. Jour. Conch., vol. 5, p. 100, pl. 9, fig. 23.
1905. *Liroscapha squamosa* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.

Description.—Shell subelliptical in outline, pointed at the beak, rounded at the opposite extremity, the sides nearly straight and parallel. The upper valve rather strongly convex, marked by unequal, radiating, squamose or spinulose costæ.

The dimensions of the type specimen are: length, 15 mm.; width, 7.5 mm.

Remarks.—In describing this species as the type of the new genus *Liroscapha*, Conrad expressed some doubt as to its true relations, expressing the possibility of its being a univalve. The recent collections of the Survey have brought no additional specimens to light and nothing can be added at this time to our knowledge of the form.

Formation and locality.—Woodbury clay, Haddonfield (183).

Geographic distribution.—New Jersey.

Family LIMIDAE.

Genus LIMA Brugière.

Lima pelagica (Morton).

Plate LIV., Fig. 7.

1833. *Plagiostoma pelagica* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 293, pl. 5, fig. 2.
1834. *Plagiostoma pelagicum* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 61, pl. 5, fig. 2.
1861. *Ctenoides pelagica* Gabb, Synop. Moll. Cret. Form., p. 171 (114).
1860. *Ctenoides pelagica* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 276.

1864. *Lima pelagica* Meek, Check List Inv. Foss. N. A., Cret and Jur., p. 7.
1868. *Radula pelagica* Con., Cook's Geol. N. J., p. 724.
1886. *Radula pelagica* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 61, pl. 9, figs. 3 and 5 (not fig. 4).
1905. *Lima pelagica* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.

Description.—Shell, in large examples, attaining a height of 33 mm., a width of 25.5 mm., and a thickness of about 21.5 mm.; oblique subovate in outline, the valves not gaping posteriorly. The hinge-line straight, its length about one-third of the greatest length of the shell, the hinge area of moderate height, with a large central cartilage pit, hinge edentulous; beaks at about the center of the hinge-line, auriculations small, nearly equal. The valves strongly convex and marked by about 25 strong, subangular or rounded plications, and usually with a minute, elevated rib in the bottom of each interspace; fine concentric lines of growth, with sometimes an occasional stronger one, also mark the entire surface of the shell.

Remarks.—This is a common member of the Navesink fauna, and, besides its large size, it is characterized by the presence of the minute secondary radiating ribs in the bottoms of the interspaces between the primary plications of the shell, and by the more or less subangular primary ribs. Whitfield included in this species the shells described in the present report as *Lima whitfieldi,* in which the secondary ribs are wanting and in which both the plications and interspaces are rounder. In general form the two shells are essentially identical, and in the internal casts, the condition in which the species usually occurs, they probably cannot be separated. The secondary ribs are more or less variable in the degree of their development in different individuals, and are always more conspicuous on the anterior portion of the shell, sometimes being faintly developed or entirely absent from the central and posterior portion.

Morton would probably have included both of these forms under his species *R. pelagica,* but the shells to which the name is here restricted are by far the commonest forms of the genus in

the Navesink marl, and Morton's original specimen is one of these shells.

Formation and locality.—Navesink marl, near Crawfords Corners (126[7]), Crosswicks Creek (147[4], 149), near Holmdel (128[5]), near Jacobstown (150), Mullica Hill (169), Holmdel and Freehold (Whitfield).

Geographic distribution.—New Jersey

Lima whitfieldi n. sp.

Plate LIV., Fig. 8.

1886. *Radula pelagica* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 61, pl. 9, fig. 4 (not figs. 3 and 5).

Description.—The dimensions of the type specimen are: extreme length, 25 mm.; greatest width, 21.5 mm.; length of hinge-line, 8 mm.; convexity of one valve, 7 mm. In general form and proportions this shell is essentially identical with *R. pelagica,* but it has not been observed to attain so large a size as that species, and differs fundamentally in the character of the surface markings. In this species the plications and interspaces are always rounded and lack entirely the secondary riblets which are present in the bottom of the interspaces in *R. pelagica.* In addition to the ribs the shell is entirely covered with fine concentric markings.

Remarks.—The type of this species is one of the specimens which Whitfield illustrates as *R. pelagica.* The specimen has the shell well preserved, showing all the surface features, as well as the hinge; it is preserved in a rather coarse sand cemented with calcium carbonate, the so-called "limestone nodules" of Whitfield, said to come from the base of the "lower marl." The horizon of these calcareo-arenaceous masses as observed in recent field work, is near the very base of the Navesink, or in the uppermost beds of the Wenonah. A few other specimens from the Marshalltown clay-marl are referred to this species, although they differ somewhat from the type in having narrower interspaces between the ribs and in having stronger concentric markings.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177); Navesink marl, near Holmdel (Whitfield).

Lima lorillardensis n. sp.

Plate LIV., Figs. 5–6.

Description.—The dimensions of the type specimen are: height, 27 mm.; width, 22 mm.; thickness, about 16.5 mm. Shell oblique, subovate in outline; valves rather strongly convex, marked by 30 to 35 strong ribs, those on the central portion of the shell being much stronger than those towards the lateral margins, these larger ribs are subcarinate on top, with a somewhat conspicuous shoulder about half-way down each slope, the interspaces rounded in the bottom and somewhat broader than the ribs, the lateral ribs are much narrower, lower and lack the lateral shoulders. Entire surface marked by fine, regular concentric lines.

Remarks.—The type and only specimen of this species seen is a somewhat crushed and distorted internal cast whose exact form and proportions cannot be determined, and a portion of the impression of the exterior which preserves the surface markings very perfectly. The shell apparently has much the same size and proportions as *L. whitfieldi,* but its distinguishing characters are to be found in the surface markings. The species somewhat resembles *L. squarrosa* Gabb, from Alabama, but that species has broader, higher and more square ribs, which are not carinate, and less strongly marked concentric lines.

Formation and locality.—Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey.

Lima reticulata Lyell and Forbes.

Plate LIV., Figs. 3–4.

1845. *Lima reticulata* L. & F., Quart. Jour. Geol. Soc. Lond., vol. 1, p. 62, with two text figures.

1861. *Ctenoides reticulata* Gabb, Synop. Moll. Cret. Form., p. 171 (114).

1864. *Lima reticulata* Meek, Check List Inv. Foss. N. A., Cret and Jur., p. 7.

1868. *Radula reticulata* Con., Cook's Geol. N. J., p. 725.

1886. *Radula reticulata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 63, pl. 9, figs. 8–9.

Description.—"Shell small, moderately oblique, strongly ovate and inflated. Hinge short; beaks proportionately strong and projecting beyond the cardinal line. Valves nearly equal; anterior margin straight and not at all gaping; auriculations small but distinct, rectangular or very slightly pointed at their outer angles. Surface radiately ribbed, those of the anterior and posterior slopes faintly marked or obsolete, ribs (about 30) distinct, with five or more indistinct on each side; subangular on the middle of the valves and rounded toward the sides, crenulate or subspinose on the larger specimens when well preserved, but often appearing nearly smooth. Entire surface marked by concentric lines which give a roughened surface when perfect, giving the reticulated character indicated by the specific name." (Whitfield.)

Remarks.—This species is frequently associated with *L. pelagica,* but it can always be distinguished from it by reason of its smaller size and its much finer plications. The specimens are usually preserved in the form of internal casts so that the delicate concentric surface markings cannot be detected, but upon some specimens from the Marshalltown marl near Swedesboro the shell is perfectly preserved. Whitfield has considered *Lima denticulicosta* Gabb as a synonym of *L. reticulata.* In this he is probably in error, since that species is described as having "about 28 ribs," while usually as many as 40 may be easily recognized upon specimens of *R. reticulata,* and furthermore the surface markings are very different in the two species.

The specimens from New Jersey, which have sometimes been identified as *Radula acutilineata,* are probably members of this species. No specimens agreeing with typical individuals of *L. acutilineata* have come under the observation of the writer during the prosecution of the present work.

Formation and locality.—Merchantville clay-marl, near Matawan (101), Lenola (163); Marshalltown clay-marl, near Swedesboro (177); Wenonah sand, near Crawfords Corner (126[3]); Navesink marl, Atlantic Highlands (108), near Red

Bank (120), near Crawfords Corners (126[7]), near Walnford (148[2]), Crosswicks Creek (149, 147[4], 195), Mullica Hill (169[2]); Red Bank sand, Shrewsbury River (119), Red Bank (123); Tinton beds, near Freehold (132).

Geographic distribution.—New Jersey.

Lima monmouthensis (Whitfield).

Plate LIV., Fig. 9.

1886. *Nucula Monmouthensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 102, pl. 11, fig. 1.

Description.—Shell small, the dimensions of the type specimen being: height, 12 mm.; length, 11 mm.; convexity of one valve, 3 mm. Valves oblique, moderately convex, subovate in outline not gaping; hinge-line short, arcuate, edentulous; beaks near the center of the hingle-line, auriculations absent. Surface of valves marked only by faint, concentric lines of growth.

Remarks.—This little shell was described by Whitfield as a member of the genus *Nucula*. A further development of the type specimen has shown the entire absence of the nuculoid hinge, and the essential agreement of the shell in all its characters with members of the genus *Lima*. A second specimen in the collection of the Philadelphia Academy of Science, referred to, but not illustrated, by Whitfield is a true *Nucula*. The species differs from all other members of the genus *Lima* recognized in the Cretaceous faunas of New Jersey, in the absence of radiating plications, and in the obsolesence of the auriculations.

Formation and locality.—Wenonah sand, Marlboro (Whitfield).

Geographic distribution.—New Jersey.

Lima sp. undet.

A single imperfect specimen of what seems to be an undescribed species of *Lima* occurs in the Survey collection from the arenaceous Navesink bed at Mullica Hill. When

complete it must have had much the form and proportions of *L. pelagica,* with a height of about 30 mm. It differs, however, from all other members of the genus in the New Jersey faunas, in the smaller number of radiating ribs, there being only 12 or 13 in all, two or three of these upon the posterior slope being very faint; the interspaces between the ribs are much broader than the ribs themselves.

Formation and locality.—Navesink. marl, Mullica Hill (169).

Geographic distribution.—New Jersey.

Genus Plagiostoma Sowerby.

Plagiostoma erecta (Whitfield).

Plate LIV., Fig. 10.

1886. *Dosinia ? erecta* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 162, pl. 18, fig. 17 (?18–20).

Description.—Shell very thin, depressed convex, subcircular in outline, a little longer than high, in large examples attaining a length of 25 mm., a height of 22.5 mm. and convexity of 4.5 mm. Beaks nearly erect, situated back of the middle of the valves, antero-cardinal margin deeply inflected to form an excavated escutcheon, back of the beaks the shell is compressed and produced into a small triangular auriculation; the anterior extremity of the hinge-line meeting the anterior shell margin in a slightly obtuse angle. The posterior margin slightly sinuate above from the hinge extremity to below the base of the auriculation; beyond this point the margin describes a nearly circular curve to the posterior hinge extremity. The surface smooth and shining, marked by fine concentric lines of growth.

Remarks.—This species was established by Whitfield "entirely from the external appearances of a few shells destitute of the most of the cardinal portions, and one internal cast, on which the markings are so faint as not to be considered reliable," and was referred to the genus *Dosinia.* The internal cast mentioned by Whitfield may belong to the same species as the specimens preserving the shells, but it is not possible to affirm

this with any certainty, and the specimens preserving the shells will be considered as the types of the species. These specimens are two in number from Marshalltown, N. J., and they undoubtedly came from the Marshalltown clay-marl. Several additional specimens of the same form are preserved in the more recent collections of the Survey from the same formation near Swedesboro, and these, with some others from the Navesink marl, present additional features of the shell not seen by Whitfield, which show the species to be a member of the genus *Plagiostoma*. Whitfield's figure of the specimen preserving the shell (fig. 17), either was considerably restored in the drawing, or the specimen has been injured since he studied it. This specimen does not retain the posterior auriculation of the shell, although after observing it in other individuals, it may be seen that it was originally present in this type. The species may be compared with *P. hoperi* Mant., from the upper chalk of England.[1]

Formation and locality.—Marshalltown clay-marl, Marshalltown (Whitfield), near Swedesboro (177, 179, 180); Navesink marl, near Crawfords Corners (126[7]), near Holmdel (128[3]), Crosswicks Creek (149).

Geographic distribution.—New Jersey.

Super-family ANOMIACEA.

Family ANOMIIDAE.

Genus ANOMIA Linneus.

Anomia argentaria Morton.

Plate LIV., Figs. 11–15.

1833. *Anomia argentaria* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 293, pl. 5, fig. 10.
1833. *Anomia tellinoides* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 294, pl. 5, fig. 11.
1834. *Anomia argentaria* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 61, pl. 5, fig. 10.

[1] Woods, Monog. Cret. Lam. Eng., vol. 2, pt. 1, p. 17, pl. 4, figs. 7–12.

1834. *Anomia tellinoides* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 61, pl. 5, fig. 11.
1858. *Anomia sellæformis* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 3, p. 330, pl. 34, fig. 6.
1861. *Anomia argentaria* Gabb, Synop. Moll. Cret. Form., p. 150 (94).
1861. *Anomia tellinoides* Gabb, Synop. Moll. Cret. Form., p. 151 (95).
1864. *Anomia argentaria* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 6.
1864. *Anomia tellinoides* Meek, Check List Inv. Foss. N. A., Cret and Jur., p. 7.
1866. *Diploschiza cretacea* Con., Am. Jour. Conch., vol. 2, p. 77.
1868. *Anomia argentaria* Con., Cook's Geol. N. J., p. 724.
1868. *Anomia tellinoides* Con., Cook's Geol. N. J., p. 724.
1875. *Anomia argentaria* Con., Kerr's Geol. N. Car., App. A., p. 13.
1876. *Anomia argentaria* Gabb., Proc. Acad. Nat. Sci. Phil. (1876), p. 319.
1886. *Anomia argentaria* Whitf. Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 42, pl. 4, figs. 10–11 (not fig. 9= *Ostrea plumosa*).
1886. *Anomia tellinoides* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 43, pl. 4, figs. 12–13.
1886. *Diploschiza cretacea* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 43, pl. 4, figs. 4–8.
1905. *Anomia argentaria* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.
1905. *Anomia tellinoides* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.

Description.—Shell subcircular, more or less irregular in outline, the larger individuals attaining a diameter of 25 mm. or more. Upper valve depressed convex, with the apex marginal, or nearly marginal, the surface marked by more or less irregular, sometimes sublamellose, lines of growth, and sometimes by

more or less distinct radiating costæ. Lower valve flat, concave or convex, often irregular in contour, the perforation rather large and situated near or at some distance from the margin.

Remarks.—In common with all members of this genus, this species is exceedingly irregular in form, and also exhibits considerable variation in its surface markings. The specimens described by Morton under two specific names, *argentaria* and *tellinoides,* are quite certainly members of a single species, and *argentaria* being the prior name, must be adopted for the species. Whitfield restricted the name *A. argentaria* to a single individual studied by him, which differed from the common *Anomia* of the New Jersey faunas, called by him *A. tellinoides,* in its more regular concentric lines of growth and in its regular and conspicuous radiating costæ, and in the position of the apex of the upper valve being not so nearly marginal. The strong radiating costæ of this specimen are somewhat unusual, although specimens preserving the shells not uncommonly exhibit traces of such markings, but the other characters noted are often met with among specimens without the radiating markings. This specimen is probably not specifically distinct from the other members of the genus in the New Jersey faunas, although it may possibly be a representative of Gabb's *A. argentaria* var. *ornata.*[1]

Whitfield's figure 9 on plate IV. of his monograph. is not an *Anomia* at all, but is a shell of *Ostrea plumosa,* its designation as *Anomia argentaria* in the explanation of the plate was doubtless not so intended, since in the description of that species, as interpreted by that author, it is definitely stated that only a single individual had been observed.

The shells which Whitfield has identified as *Diploschiza cretacea* Con., seem to be nothing more than more strongly convex individuals of *Anomia argentaria.* There is certainly no sufficient basis for the genus *Diploschiza,* and Conrad's types of his species seem to have no characters to separate them from Morton's species. A specimen with the shell perfectly preserved, from the Navesink marl near Crawfords Corners, is strongly

[1] Proc. Acad. Nat. Sci. Phil. (1876), p. 320.

convex like *Diploschiza cretacea*. It possesses the regular concentric marks with the discontinuous radiating striæ of Whitfield's interpretation of *Anomia argentaria*, and the marginal apex of the same author's interpretation of *Anomia tellinoides*.

Formation and locality.—Cliffwood clay, Cliffwood Point (105), near Matawan (189); Merchantville clay-marl, near Matawan (101), near Jamesburg (140, 139, 141), Merchantville (162), Lenola (163); Woodbury clay, Lorillard (102), near Matawan (103), Crosswicks (168); Marshalltown clay-marl, near Swedesboro (177, 180); Wenonah sand, near Marlboro (130[1]); Navesink marl, near Crawfords Corners (126[7]), Middletown (113[2]), Crosswicks Creek (147[4]), Holmdel (Whitfield), ? Freehold (Whitfield); Red Bank sand, Middletown (112).

Geographic distribution.—New Jersey, North Carolina, Alabama, Mississippi, Arkansas, Texas.

Anomia radiata n. sp.

Plate LIV., Figs. 16–17.

Description.—Shell irregularly subovate in outline, the dimensions of the type specimen being: height, 12.5 mm.; width, about 20 mm. Free valve depressed convex, the apex marginal. The attached valve flatter, the perforation near the margin. Both valves marked by rather coarse, irregular, nodose, radiating costæ, the nodes being small squamose projections as shown by impressions of the exterior.

Remarks.—The example selected as the type of this species is the most complete of several individuals which are attached to the leaves of a marine plant, the plant having been fossilized with the shells attached. Impressions and casts of other individuals are not uncommonly met with in the collections from the Merchantville and Woodbury formations, but no others have been seen attached. Some of these specimens are much larger than the type, the larger ones sometimes having a maximum diameter of nearly 30 mm. In the character of their surface markings the members of this species resemble *Paranomia*

scabra, but the costæ are always finer than in that species, and the shells do not grow to so large a size. In the perforated lower valve, however, these shells possess the essential feature of the genus *Anomia.*

Formation and locality.—Merchantville clay-marl, near Matawan (101), Lenola (163); Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey.

Genus Paranomia Conrad.

Paranomia scabra (Morton).

Plate LII., Figs. 10–13.

1834. *Placuna scabra* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 62.
1860. *Paranomia saffordi* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 290, pl. 46, fig. 21.
1860. *Placunanomia lineata* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 291, pl. 46, fig. 20.
1860. *Placunanomia lineata* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 291.
1861. *Placunanomia lineata* Gabb, Synop. Moll. Cret. Form., p. 223 (167).
1861. *Placunanomia saffordi* Gabb, Synop. Moll. Cret. Form., p. 223 (167).
1861. *Placunanomia scabra* Gabb, Synop. Moll. Cret. Form., p. 223 (167).
1864. *Placunomia lineata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 6.
1864. *Placunomia saffordi* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 6.
1864. *Placunomia scabra* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 6.
1867. *Paranomia lineata* Con., Am. Jour. Conch, vol. 3, p. 8.
1867. *Paranomia scabra* Con., Am. Jour. Conch., vol. 3, p. 8.
1868. *Paranomia scabra* Con., Cook's Geol. N. J., p. 724.
1886. *Paranomia scabra* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 44, pl. 10, fig. 10.

1886. *Paranomia lineata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 45, pl. 9, fig. 10.
1905. *Paranomia scabra* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.
1905. *Paranomia lineata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.
1905. *Paranomia saffordi* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 12.

Description.—Shell thin and fragile, broadly and irregularly subovate in outline, the dimensions of the largest individual observed being: length from beak to opposite border, 55 mm.; width at right angles to the last dimension, 54 mm. The dimensions of an individual of more nearly average size are: length, 31 mm.; width, 34 mm. The upper valve depressed convex, the surface marked by distant, rounded, elevated radiating ribs, which are frequently more or less wavy in their direction and become stronger towards the front of the shell. At irregular intervals the ribs are produced into hollow spines directed away from the beak, which become larger and more distant as the ribs increase in strength towards the front of the shell; the spaces between the ribs are broad and flat, being three or four times as wide as the ribs, and on the best preserved shells are marked with rather delicate concentric lines. The lower valve is convex towards the beak, where it is apparently broadly perforate, becoming concave towards the front of the valve. The surface markings are similar to those of the upper valve, though in some cases the ribs and spines seem to be less strongly developed.

Remarks.—This species occurs most commonly in the Marshalltown clay-marl, from which formation near Swedesboro a large number of individuals retaining the shell have been collected. None of them are so large as the specimen illustrated by Whitfield under the name of *P. lineata,* but they all exhibit the same essential specific characters as that shell. Whitfield was in error, however, in considering the specimen he used for study as a perforate valve, the apparent perforation near the beak being only a fracture. In none of the Swedesboro speci-

mens, which are perfectly preserved up to the beak, is any perforation shown in the convex valve, but in several of those which become concave towards the front there is apparently a broad perforation close to the beak, although there is some reason for doubting the presence of an actual perforation in this valve, as it seems to be absent from some specimens which are complete to the beak.

There seems to be no sufficient reason for recognizing the two species of *Paranomia* of Whitfield's monograph. The type of Morton's species, *P. scabra,* illustrated by Whitfield, is only a fragment of a shell belonging to the same species as the one illustrated as *P. lineata,* although it is somewhat more irregular and rougher than usual. Morton's name having priority is adopted for the species. *P. saffordi* Con., from Tennessee, must also be considered as a synonym.

Formation and locality.—Merchantville clay-marl, Lenola (163); Marshalltown clay-marl, near Swedesboro (177, 179); Navesink marl, Crosswicks Creek (147[4], 195).

Geographic distribution.—New Jersey, Alabama, Mississippi, Tennessee.

Super-family MYTILACEA.

Family MYTILIDAE.

Genus MYTILUS Linneus.

Mytilus smocki n. sp.

Plate LV., Figs. 1–4.

Description.—Shell more or less arcuate, the larger type specimen with an extreme length of 37 mm., a maximum width of 13 mm., and thickness of both valves 18 mm. The valves strongly convex, with a rounded ridge below the middle extending from the beak to the postero-basal margin, below the ridge the surface of the valves are rather abruptly inflected, meeting nearly in a plane along the ventral margin. The beaks pointed, the dorsal and ventral margins diverging at an angle of about 35°; the hinge arcuate, passing gradually into the pos-

tero-dorsal margin which is more or less carinate, posteriorly the dorsal and ventral margins of the shell are subparallel, the posterior margin rather narrowly rounded below, the antero-ventral margin more or less concave. Adductor muscular impressions rather large, situated near the posterior extremity of the shell. Surface of the shell marked by fine radiating costæ, about three of which occupy the space of one millimeter, and also by concentric lines of growth.

Remarks.—This species is remarkable for the great convexity of the valves, the thickness of the entire shell being considerably greater than its width. Two complete specimens have been observed, both of which show the enormous thickness of the shell, although one is considerably more arcuate than the other. The surface markings have not been satisfactorily determined because the specimens are both for the most part internal casts, both of them, however, retain some indications of the fine radiating costæ, and one of them retains a small fragment of the shell itself. In the casts several concentric lines of growth are of considerable strength.

Formation and locality.—Navesink marl, near Crawfords Corners (126[7]), near Walnford (149).

Geographic distribution.—New Jersey.

Mytilus oblivius Whitfield.

Plate LV., Figs. 5–8.

1886. *Mytilus oblivius* Whitf., Pal. N. J., vol 1 (Monog. U. S. G. S., vol. 9), p. 64, pl. 17, fig. 1.

Description.—"Shell small, erect, or but very slightly curved on the buccal margin; beaks terminal, projecting and acute. Hinge line sloping at an angle of about 60° to the buccal margin; posterior margin subparallel to the anterior, and the extremity rather sharply rounded. Anterior face abrupt, and the surface of the valve gradually sloping from the umbonal angle to the posterior margin. Surface apparently marked by fine lines of growth as indicated on the cast." (Whitfield.)

Remarks.—Whitfield described this species from a single specimen collected from the summit of the Wenonah sand near Marlboro. It occurs in the recent collections of the Survey in the same horizon at a neighboring locality, but seems to be a rare form. A similar and perhaps identical species has been recognized in the Cliffwood clay fauna at Cliffwood Point, which differs from the Wenonah specimens chiefly in its much larger size.

Formation and locality.—? Cliffwood clay, Cliffwood Point (105); Wenonah sand, near Marlboro (130[1]).

Geographic distribution.—New Jersey.

Genus Modiola Linneus.

Modiola monmouthensis n. sp.

Plate LV., Figs. 9–10.

Description.—Shell small, the dimensions of an average specimen being: length, 8 mm.; width, 4.5 mm.; convexity of one valve 2.5 mm. Hinge-line about one-half the total length of the shell, beaks nearly anterior, incurved, umbo prominent; anterior margin short and rounded, ventral margin nearly straight, slightly sinuate back of the middle of the shell, posterior margin rather sharply rounded below, sloping from the posterior extremity of the hinge-line above with a slightly convex curve. Surface of the valves marked with fine radiating costæ, which, judging from the internal casts alone, are much stronger upon the posterior portion of the shell; surface also marked with concentric lines of growth.

Remarks.—This species is the only member of the genus as yet recognized in the Cretaceous faunas of New Jersey, in which the shell is marked with radiating costæ. It is also the smallest species of the genus observed, none of the individuals varying materially from the dimensions given above.

Formation and locality.—Merchantville clay-marl, near Matawan (101).

Geographic distribution.—New Jersey.

Modiola burlingtonensis Whitfield.

Plate LV., Figs. 18–19.

1886. *Modiola Burlingtonensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 65, pl. 17, figs. 8-9.
1905. *Modiolus burlingtonensis* John., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.

Description.—"Shell of moderately large size, very ventricose, and with subparallel dorsal and ventral margins, large prominent umbones and incurved beaks situated near the anterior end but not terminal, the anterior margin perceptibly extending beyond them and rounded. Umbonal ridge prominent and subangular, especially near the beaks, and becoming broader and more rounded posteriorly; surface of the valves strongly constricted and sinuate in front of the ridge and the anterior surface again inflated; cardinal slope comparatively broad and slightly concave toward the postero-cardinal border. Hinge-line straight and three-fifths as long as the shell, and rather strongly impressed in the internal cast; postero-cardinal margin rounding rapidly forward from the more narrowly rounded posterior extremity. Surface of the cast, the only condition under which it is known, apparently smooth or marked only by irregular concentric lines of growth, some of which produce undulations of considerable strength on the casts. On one individual there appears on the posterior cardinal slope very faint indications of rather coarse radiating lines, but too faint to warrant the statement that such markings really existed on the shell." (Whitfield.)

Remarks.—The horizon of this species is not satisfactorily known, as it has not been met with in any of the recent collections of the Survey, and the recorded locality. "Burlington County," is too indefinite to be of much assistance in forming an opinion. The lithologic character of the specimen, however, more closely resembles that of specimens from the Merchantville clay-marl than any others, and it is probable that it was collected from that formation.

Formation and locality.—Merchantville clay-marl, Burlington County (Whitfield).

Geographic distribution.—New Jersey.

Modiola julia Lea.

Plate LV., Figs. 12–13.

1861. *Modiola Juliæ* Lea, Proc. Acad. Nat. Sci. Sci. Phil. (1861), p. 149.
1864. *Modiola Juliæ* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 11.
1868. *Perna Juliæ* Con., Cook's Geol. N. J., p. 726.
1886. *Modiola Julia* Whitf., Pal. N. J., vol 1 (Monog. U. S. G. S., vol. 9), p. 64, pl. 17, fig. 6 (not fig. 7).
1905. *Modiolus julia* John., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.

Description.—Shell subovate in outline, the dimensions of the largest specimen observed being: length, 27 mm.; greatest height, 13 mm.; convexity of one valve, 5.5 mm.; the hinge-line about .63 of the total length; the beaks incurved, situated about one-seventh of the total length of the shell from the anterior extremity. Anterior margin rounded, meeting the hinge-line in an obtusely rounded angle, ventral margin nearly straight or slightly sinuate near the middle; if projected anteriorly it would meet the projection of the dorsal margin in an angle of about 16°; posterior margin broadly rounded, its most posterior projection below the middle. From the beak a rounded umbonal ridge passes obliquely backward to the postero-basal margin, in front of which is a rather broad, shallow, ill-defined sulcus. The surface markings of the shell consist of concentric lines of growth which are stronger and more regular upon the posterior slope.

Remarks.—The type of this species, from the Woodbury clay near Haddonfield, is a badly crushed shell 13.5 mm. in length, which is just one-half the size of the larger individual figured in the present report from Lorillard. This fact is in agreement, however, with nearly all the species which are common to these two localities, the Lorillard individuals generally being much larger than those from Haddonfield. The Haddonfield specimen of this species is proportionally much shorter than those from Lorillard, but this difference is doubtless due to the dis-

tortion of the former, and it is believed that the Lorillard specimens much more nearly exhibits the normal form of the shell. The original of Whitfield's figure 7 is not a member of this species, and judging from its lithologic characters it must have come from a much higher horizon, certainly from one of the marl beds and possibly the Manasquan.

Formation and locality.—Merchantville clay-marl, near Jamesburg (141); Woodbury clay, Lorillard (102), Farry's clay pits near Matawan (103), near Haddonfield (165, 183).

Geographic distribution.—New Jersey, Texas.

Modiola wenonah n. sp.

Plate LV., Fig. 11.

Description.—Shell small, the dimensions of the type specimen being: length, 15 mm.; width, 8 mm.; convexity, 3.5 mm. The hinge-line a little more than one-half the length, the beaks nearly anterior, umbo rather prominent with a somewhat broadly rounded umbonal ridge extending to the postero-basal margin. Anterior margin rather broadly rounding into the nearly straight basal margin which is slightly sinuate back of the middle, postero-basal margin rather sharply rounding into the long, oblique, slightly convex upper portion of the posterior margin which meets the posterior extremity of the hinge-line at an angle of about 125°. Surface of the internal cast marked by indistinct concentric lines of growth.

Remarks.—This species is based upon a single individual from the top of the Wenonah sand near Marlboro. It differs from all other members of the genus in the New Jersey Cretaceous faunas, in the conspicuous postero-basal extension of the shell with the long oblique posterior slope above.

Formation and locality.—Wenonah sand, near Marlboro (130[1]).

Geographic distribution.—New Jersey.

Modiola subinflata Whitfield.

Plate LV., Figs. 20–21.

1886. *Modiola* (*Lithodomus* ?) *inflata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 197, pl. 26, figs. 1-2 (preoccupied).

1899. *Modiola subinflata* Whitf., Ann. N. Y. Acad. Sci., vol. 12, p. 160.

Description.—"Shell small, cylindrically ovate, with large, tumid, anterior beaks, and parallel dorsal and basal margins. Anterior and posterior ends nearly equally rounded in a general view, as the beaks, from their downward direction of curvature as seen in a lateral view, are blended with the anterior margin so nearly as to give almost the same form as the posterior end. In a dorsal view the form is strongly cuneately ovate from the rapid attenuation of the shell posteriorly. Hinge-line rather short and the ligament slender." (Whitfield.)

Remarks.—"This species bears considerable resemblance to *Modiola Johnsoni,* but never attains so great a size, is more cylindrical, with a differently formed beak, and a different surface structure, being smoother and destitute of the strong concentric markings so prominent on that one, and is also more attenuated behind. There are some features about the shell in its general expression which are almost indescribable, but which give it more the appearance of a species of *Lithophagus* than that of a true *Modiola,* and leave an uncertainty about its true generic relations, the specimens being only casts." (Whitfield.)

The dimensions of the type specimen are: length, 15.5 mm.; height, 7.5 mm.; thickness, 7.5 mm.

Formation and locality.—Hornerstown marl, Mr. Ware's pits, near Mullica Hill. (Whitfield.)

Geographic distribution.—New Jersey.

Modiola ovata Gabb.

Plate LV., Figs. 16–17.

1860. *Modiola ovata* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 396, pl. 68, fig. 31.

1861. *Modiola ovata* Gabb, Synop. Moll. Cret. Form., p. 199 (143).

1864. *Modiola ovata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 11.

1868. *Perna ovata* Con., Cook's Geol. N. J., p. 726.
1886. *Modiola ovata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 197, pl. 26, figs. 13-14.
1905. *Modiolus ovatus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 12.

Description.—"Shell ovate in outline, or elongate ovate, of about a medium size, somewhat alate at the extremity of the short hinge-line. Valves very ventricose, with nearly terminal beaks, which are small, incurved, and not conspicuously raised above the cardinal line. Umbonal ridge prominently rounded, and the surface of the shell in front of it slightly sinuate, giving a slight sinuosity to the basal line; posterior extremity of the shell broadly rounded, and the anterior end narrow. Surface of the shell marked by very fine, obscure lines of growth." (Whitfield.)

Formation and locality.—Vincentown limesand, Timber Creek. (Whitfield.)

Geographic distribution.—New Jersey.

Modiola johnsoni Whitfield.

Plate LV., Figs. 14–15.

1886. *Modiola Johnsoni* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 207, pl. 28, figs. 8-9.

Description.—"Shell small, measuring, in the only perfect example of a cast seen, but little more than an inch in its extreme length. Form ovate, widest behind the middle, and somewhat narrowed anteriorly, while the posterior end is acutely rounded; beaks large, tumid, nearly anterior, slightly enrolled and approximate. Anterior end narrow, the projection scarcely extending beyond the beaks. Valves very ventricose, the umbonal ridge very full and rounded. Ligament short, slender, but distinctly marked; a slight constriction or sulcus marks the basal half of the width of the shell anterior to the middle of its length. Surface of the shell as seen in casts marked by very fine concentric

lines parallel to the margin, and also by several varices of growth at irregular intervals." (Whitfield.)

Remarks.—"This species somewhat approaches *M. Julia* Lea's sp., but is not alate posteriorly as is that species, and the posterior end is much more narrowly rounded. It also presents much the appearance of the enlarged figures of *Lithophagus inflatus* herein described, but is less cylindrical, being fuller or more convex on the basal margin and the beaks are not so broad. It also holds a different geological position." (Whitfield.)

The dimensions of the type specimen are: length, 27 mm.; height, 14 mm.; thickness, 15.5 mm.

Formation and locality.—Manasquan marl, Farmingdale (138).

Geographic distribution.—New Jersey.

Genus CRENELLA Brown.

Crenella serica Conrad.

Plate LVI., Figs. 7–8.

1860. *Crenella* (*Stalagmium*) *serica* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 281, pl. 46, fig. 23.

1861. *Crenella serica* Gabb, Synop. Moll. Cret. Form., p. 169 (113).

1864. *Crenella* (*Stalagmium*) *sericea* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 11.

Description.—Shell small, the dimensions of an average individual being: greatest length, 4 mm.; greatest width, 3 mm. Oblique, subovate in outline, strongly convex, the umbo prominent, the beaks incurved. The anterior slope from the umbo abrupt, inflected towards the anterior extremity of the hinge-line. Surface marked by fine, regular, concentric lines which can be easily seen with the unaided eye, and by finer, regular, radiating striæ which can usually be seen only with a magnifying glass.

Remarks.—This beautiful little species, which has hitherto been placed on record only from its original locality, Eufaula, Alabama, occurs in New Jersey in the Marshalltown clay-marl and

in the Red Bank sand. Near Swedesboro, in the first of these formations, the specimens are rather common and occur with the shell perfectly preserved. In this condition the shell is covered externally with a brownish epidermal layer which is easily exfoliated. Upon the exfoliated shells the radiating markings are much more conspicuous than upon the epidermal surface. The Red Bank specimens have only been recognized from the impressions of the external surface of the shells.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177); Red Bank sand, Red Bank (116), near Middletown (112).

Geographic distribution.—New Jersey, Alabama, Mississippi, Texas.

Crenella elegantula Meek & Hayden.

Plate LVI., Fig. 6.

1861. *Crenella elegantula* M. & H., Proc. Acad. Nat. Sci. Phil., 1861., p. 441.
1864. *Crenella elegantula* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 11.
1876. *Crenella elegantula* Meek, Rep. Inv. Cret. and Ter. Foss. Up. Mo., p. 75, pl. 28, figs. 6 a-c.

Description.—Shell obliquely subovate in outline; the dimensions of a perfect cast of a left valve are: height, 10.5 mm.; width, 8.5 mm.; convexity, 5 mm. Valves ventricose, umbo prominent, beak nearly terminal, small and strongly incurved. Surface marked by exceedingly fine radiating costæ which can be seen upon the internal cast, indicating that the shell substance was very thin.

Remarks.—This species differs from *C. serica* in its much larger size, its proportionally broader form, and in the absence of the conspicuous concentric markings of the shell. The New Jersey examples are apparently identical with the western specimens from which the species was described, and the same form occurs in the southern Ripley beds.

Formation and locality.—Tinton beds, Beers Hill cut, south of Keyport (129[5]).

Geographic distribution.—New Jersey, Mississippi, Wyoming, Montana, Colorado.

Genus LITHOPHAGA Bolton.

Lithophaga ripleyana Gabb.

Plate LVI., Figs. 9–12.

1861. *Lithophagus Ripleyanus* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 326.
1861. *Lithophagus affinis* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 327.
1864. *Lithophagus affinis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 10.
1864. *Lithophagus ripleyanus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 10.
1868. *Lithophagus affinis* Con., Cook's Geol. N. J., p. 726.
1875. *Arcoperna carolinensis* Con., Kerr's Geol. N. Car., App. p. 5, pl. 1, fig. 6.
1876. *Lithophaga ripleyana* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 311.
1886. *Lithodomus affinis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 66, pl. 17, figs. 2-3.
1886. *Lithodomus ripleyana* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 67, pl. 17, figs. 4-5.
1905. *Lithophaga affinis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 13.
1905. *Lithophaga ripleyana* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 13.

Description.—Shell more or less subcylindrical, sometimes curved downward posteriorly, attaining a length of 15 mm. to 20 mm. in full grown specimens, the width and thickness usually about one-half the length. Anterior extremity of the shell bluntly rounded, the beaks blunt, anterior or nearly terminal in position; posterior extremity of the shell compressed. Dorsal

margin marked by an impressed line between the valves. Surface of the shell, which is rarely preserved, marked by lamellose, concentric lines of growth.

Remarks.—This species occurs most frequently in the Navesink marl, where it attains its maximum size, but one colony of shells has been detected in the recent Survey collections from the Wenonah sand, the individuals of which seem not to differ from those in the Navesink, except that none of them exceed 10 mm. in length. In connection with his original description, Gabb mentions having collected one specimen of the species from near the place now known as Westville, the horizon of which would be Merchantville clay-marl, but the species has not been detected in the recent collections of the Survey from this horizon.

Gabb's two species, *ripleyana* and *affinis,* are undoubtedly not distinct, and are here united under the one name *ripleyana.* Gabb himself recognized the identity of the two forms in his later notes on the species in 1876, but Whitfield has recognized both forms. Among such burrowing and attached shells it is necessary to allow a far greater range of variation than in most others. These shells burrow into various substances, usually wood, but Whitfield mentions finding them in the shell of *Gervillopsis ensiformis,* and they have been observed by the writer burrowing in the shells of *Gryphaea vesicularis* at Mullica Hill.

Formation and locality.—Merchantville clay-marl, near Westville (Gabb); Wenonah sand, near Crawfords Corner (126[3]); Navesink marl, Marlboro (131), Crosswicks Creek (195), near Walnford (148[2]), Mullica Hill (169).

Geographic distribution.—New Jersey.

Order ANOMALODESMACEA.

Super-family ANATINACEA.

Family PHOLADOMYACIDAE.

Genus PHOLADOMYA Sowerby.

Pholadomya occidentalis Morton.

Plate LVI., Figs. 1–3.

1833. *Pholadomya occidentalis* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 292, pl. 8, fig. 3.

1834. *Pholadomya occidentalis* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 68, pl. 8, fig. 3.
1860. *Pholadomya occidentalis* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 276.
1860. *Pholadomya occidentalis* Owen, 2nd Rep. Geol. Recon. Ark., pl. 8, fig. 9.
1861. *Pholadomya occidentalis* Gabb, Synop. Moll. Cret. Form., p. 221 (165).
1864. *Pholadomya occidentalis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 14.
1868. *Pholadomya occidentalis* Con., Cook's Geol. N. J., p. 727.
1886. *Pholadomya occidentalis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 175, pl. 24, figs. 1-3.
1905. *Pholadomya occidentalis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 13.

Description.—The dimensions of an average sized specimen are: length, about 70 mm.; height, 47 mm.; thickness, 45 mm. Shell subovate or subelliptical in lateral outline, and cordate from in front. Hinge-line straight, about two-thirds as long as the shell; anterior margin rounding from the cardinal extremity into the basal margin, or obliquely subtruncate; basal margin gently convex, becoming straighter posteriorly; posterior margin more narrowly rounded than the anterior. Beaks large and broad, situated from one-fifth to one-fourth the length of the shell from the anterior extremity, strongly incurved and nearly in contact, moderately elevated above the hinge-line. Valves most prominent at about their mid-height in front of the middle of the shell; from this point the surface curves rather abruptly to the ventral anterior and cardinal margins, and much more gently to the gaping posterior margin; the cardinal margins back of the beaks are slightly inflected to form a rather distinct, concave cardinal area of moderate width on each valve. Surface of each valve marked by 25 to 30 more or less irregular and wavy, rounded, radiating costæ of moderate strength, much narrower than the intervening depressions, and closer together in the middle of the shell than at either the anterior or posterior

portions; in the middle of the shell every other costa on large individuals has usually been intercalated between two others at some distance below the beak; the shell is also marked by more or less irregular, concentric undulations.

Remarks.—This species is one of the most characteristic members of the Merchantvile clay-marl fauna, where it sometimes occurs in considerable numbers. In all other formations where it occurs in New Jersey, it is exceedingly rare. The species seems to be a perfectly typical species of *Pholadomya* in all respects.

Formation and locality.—Cliffwood clay, Cliffwood Point (105), near Matawan (107); Merchantville clay-marl, near Matawan (101), near Jamesburg (139, 141), Lenola (163); Woodbury clay, near Matawan (103).

Geographic distribution.—New Jersey, Alabama, Mississippi, Arkansas.

Pholadomya roemeri Whitfield.

Plate LVI., Figs. 4–5.

1886. *Pholadomya Roemeri* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 176, pl. 24, fig. 4.

Description.—The approximate dimensions of a rather small specimen are: length, 38 mm.; height, 22 mm.; thickness, 18 mm. Shell very oblique and inequilateral, elongate subovate in outline, widest back of the middle. Beaks small, incurved and nearly in contact, situated far forward. Hinge-line straight, rather long; anterior margin rounding from the anterior cardinal extremity into the basal margin; basal margin gently convex, curving upward posteriorly; posterior margin rather sharply rounded above the mid-height of the shell. Valves strongly convex or ventricose, the surface curving rather abruptly from the prominent umbones to the dorsal, anterior and ventral margins, much more gently to the posterior margin. Surface of each valve marked by about 13 narrow, angular, radiating costæ, separated by broad, concave interspaces; the most anterior costæ curve slightly forward in passing from the beak to the margin of the

shell. The surface is also marked by more or less irregular concentric lines of growth.

Remarks.—This species is a much smaller and more elongate form than *P. occidentalis,* and the two are never found associated in the same fauna. It also has a much smaller number of costæ which are relatively more distant than in the larger species.

Formation and locality.—Wenonah sand, near Marlboro (130).

Geographic distribution.—New Jersey.

Family ANATINIDAE.

Genus ANATINA Lamark.

Anatina jerseyensis n. sp.

Plate LVII., Figs. 1–4.

Description.—The dimensions of a nearly complete internal cast are: length, 44 mm.; height, 29 mm.; thickness, 11 mm. Shell subovate in outline, a little gaping posteriorly, much broader in front than behind; beaks transversely fissured, situated back of the middle, pointing posteriorly. Antero-cardinal margin straight and nearly horizontal in front of the beak, curving gradually downward in front; anterior margin broadly rounded from the cardinal to the basal margins; basal margin nearly straight in the middle, curving upward at each end; posterior margin with its greatest extension above the middle of its height, curving into the basal margin below and the cardinal margin above; post-cardinal margin strongly concave. Valves depressed convex, most prominent in the umbonal region, abruptly compressed towards the postero-cardinal extremity, the anterior and ventral slopes gently convex. Shell marked by more or less irregular concentric lines of growth.

Remarks.—This species resembles *Periplomya elliptica,* but is larger, less cuneate behind, and lacks the curved angular umbonal ridge of that species. It seems to be a true *Anatina,* although it might be included in Conrad's genus *Periplomya,* it being difficult to distinguish between these two genera in the internal casts.

Formation and locality.—Merchantville clay-marl, near Jamesburg (141); Woodbury clay, Lorillard (102); Wenonah sand, near Marlboro (130).

Geographic distribution.—New Jersey.

Anatina clifwoodensis n. sp.

Plate LVII., Figs. 5–6.

Description.—Shell small, the dimensions of the type specimen being: length, about 18 mm.; height, 12 mm.; thickness, 6 mm. Shell subovate in outline, apparently a little gaping posteriorly, much broader in front than behind. Beaks compressed, directed backward, fissured transversely, situated about seven-ninths of the length of the shell from the anterior extremity, antero-cardinal margin straight and nearly horizontal in front of the beaks, curving downward in front into the broadly rounded anterior margin; basal margin gently convex curving upward more strongly at each end; posterior margin shorter and probably more sharply rounded than the anterior. Valves depressed-convex, more prominent in the umbonal region, abruptly compressed towards the postero-cardinal extremity, the anterior and ventral slopes greatly convex. Shell marked by rather fine concentric lines of growth.

Remarks.—This species resembles the one described in this report as *Anatina jerseyensis,* but may be distinguished by reason of its smaller size more elongate form, and by the much more posterior position of the beaks.

Formation and locality.—Cliffwood clay, Cliffwood Point (185).

Geographic distribution.—New Jersey.

Anatina jamesburgensis n. sp.

Plate LVII., Fig. 7.

Description.—The type specimen is only the dorsal portion of a shell preserved as a mould of the exterior, and the ventral outline can be determined only by restoration from the direction of

the concentric markings of that portion of the shell which is preserved. The dimensions of the restored type are: length, 37 mm.; height, estimated, 20 mm.; thickness about 7.5 mm. Beaks incurved and nearly or quite in contact, situated back of the middle of the shell, pointing backward. Antero-cardinal margin straight and nearly horizontal in front of the beaks, curving downward in front; anterior margin rounding from the cardinal into the basal margin; basal margin slightly convex in the middle, curving upward in front and behind; posterior margin apparently rounded. Valves most prominent below the umbonal region, the surface curving rather abruptly to the cardinal margin, gently convex to the anterior and ventral margins; posteriorly the valves are rather abruptly depressed along a line running obliquely backward from the beaks, so that the postero-cardinal portion of the shell is conspicuously compressed. Surface of the shell marked by rather strong concentric undulations and by fine concentric lines of growth; the postero-cardinal compressed portion of the shell is apparently smooth, but the character of the markings of this portion of the shell is not clearly shown on the specimen.

Remarks.—This species is much like *A. jerseyensis*, but it is proportionally more elongate and not so high. It is also marked by the conspicuous, somewhat regular, rounded, concentric undulations which are wanting in the other species.

Formation and locality.—Merchantville clay-marl, near Jamesburg (139, 140).

Geographic distribution.—New Jersey.

Genus CERCOMYA Agassiz.

Cercomya peculiaris (Conrad).

Plate LVI., Figs. 13–14.

1869. *Inoceramus peculiaris* Con., Am. Jour. Conch., vol. 5, p. 43, pl. 1, fig. 13.

1870. *Cercomya peculiaris* Con., Am. Jour. Conch., vol. 6, p. 76.

1886. *Cercomya peculiaris* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 178, pl. 23, figs. 24-25.

1905. *Cercomya peculiaris* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 13.

Description.—The dimensions of the type specimen are: length, approximately 50 mm.; height, 29 mm. Shell subtrapezoidal in outline; beaks considerably in front of the middle of the shell. Anterior margin obliquely truncate above, sloping abruptly downward from the beak, sharply rounded below into the basal margin; basal margin gently convex; posterior margin probably broadly rounded; post-cardinal margin concave just back of the beak, probably becoming straighter posteriorly. Valves moderately convex. Surface marked by strong, concentric wrinkles of growth.

Remarks.—This species is known from the single type specimen which is a mere fragment showing only the anterior portion of a left valve, and probably represents less than one-half of the entire valve. The outline of the posterior portion of the valve can only be judged by the direction of the concentric lines of growth upon the umbonal portion of the type specimen. The specimen was originally described by Conrad as an *Inoceramus* as follows: "Subequilateral; ? convex, posterior margin rectilinear, very oblique, extremely angular; ribs prominent, concentric." The so-called posterior margin in this description is without doubt in reality the anterior margin, and is so considered in the description given above.

Formation and locality.—? Woodbury clay, Crosswicks, (Conrad).

Geographic distribution.—New Jersey.

Genus ANATIMYA Conrad.

Anatimya anteradiata Conrad.

Plate LVII., Fig. 12.

1860. *Anatimya anteradiata* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 276, pl. 46, fig. 3.

1861. *Pholadomya anteradiata* Gabb, Synop. Moll. Cret. Form., p. 220 (164).

1864. *Anatimya anteradiata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 14.

Description.—The dimensions of a right valve are: length, 56 mm.; height, 31 mm. Shell subelliptical in outline, the beaks small, subcentral in position, scarcely elevated above the hinge-line, pointing posteriorly, fissured. Antero-cardinal margin straight and horizontal in front of the beak, curving downward anteriorly; anterior margin broadly rounding from the cardinal to the basal margins; basal margin curving upward in front and behind, nearly straight in the middle, subparallel with the dorsal margin; posterior margin most produced near the cardinal line, curving broadly to the basal margin and more sharply to the cardinal extremity; post-cardinal margin concave just behind the beaks, becoming nearly straight posteriorly. Valves depressed convex, a little gaping behind. Surface of the shell in front of the beaks, marked by rather strong, more or less irregular concentric undulations, and by fine, more or less irregular lines of growth; posterior half of the shell marked by more or less inconspicuous concentric markings, and by about 10 or 12 narrow, angular, radiating costæ, the most anterior of which extends nearly vertically downward from the beak to the ventral margin, being slightly bowed forward; back of this is a rather broad smooth space beyond which the costæ reappear, the intervals between them gradually becoming wider posteriorly, the most posterior one reaching the posterior margin of the shell near the middle, leaving a smooth area for some distance below the cardinal border.

Remarks.—This species, originally described from Tippah County, Mississippi, has not been previously recognized in New Jersey. It occurs in the recent collections of the Survey in both the Woodbury clay and the Wenonah sand. In the original description of the species the anterior and posterior extremities of the shell were reversed. There was also published at the same time with the definition of this species, the descriptions of two others, *A. postsulcata* and *A. papyria*, but the types of both of these have apparently been lost or destroyed. However, both are probably only variations of *A. anteradiata* and are not worthy of recognition as distinct species. The species is an abundant one at the original locality in the Ripley beds of Tip-

pah County, Mississippi, and a comparison of the New Jersey specimens with the many excellent examples in the National Museum at Washington, as well as with the type of the species in the collection of the Philadelphia Academy of Science, has demonstrated the specific identity of the specimens from the two regions.

Formation and locality.—Woodbury clay, Lorillard (102); Wenonah sand, near Marlboro (130[1]).

Geographic distribution.—New Jersey, Mississippi.

Anatimya lata (Whitfield).

Plate LVII., Fig. 13.

1886. *Pholas ? lata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 189, pl. 25, fig. 17.

Description.—"Shell large and proportionally very broad between dorsal and basal margins, the relative height and length being about as two to three, respectively. The general outline is slightly ovate, widest at the anterior end and gradually narrowing posteriorly, the beak being a little in advance of the middle and showing somewhat above the cardinal line in the slightly compressed and somewhat crushed specimen of an internal cast of a left valve, the only one yet seen. Anterior and posterior ends rounded, the latter one most narrowly so; basal line slightly emarginate just behind the middle of its length; cardinal line apparently arcuate throughout. Surface of the shell, as shown on the cast, convex, with a broad sulcus passing across the valve from beak to base, reaching the latter behind the middle. Anterior to the sulcus the surface is radiately ribbed, the rays being somewhat alternate in size over a portion of the space. At the bottom of the broad sulcus there is a single larger and stronger rib, which passes from the beak directly to the base of the shell, which it reaches at the point of greatest emargination. Posterior to this larger rib the surface is destitute of radiating lines, the surface being marked only with broad, irregular, concentric sulci, which extend over the entire surface parallel to the margin of the shell." (Whitfield.)

Remarks.—The type specimen of this species, which is the only one which has been observed, is poorly preserved, but it is clearly a member of the genus *Anatimya* rather than *Pholas*, and is possibly identical with *A. postsulcata* Con. The type of Conrad's species is only a fragment exhibiting the inside of the shell, but both the concentric and radiating markings are finer than in Whitfield's species. In Whitfield's description of the species, quoted above, the anterior and posterior extremities of the shell are evidently reversed.

The horizon of the species is stated by Whitfield to be "Lower Green Marls" and the locality "Marlborough, N. J." The specimen itself is an internal cast of rather dark sand with some larger, lighter colored quartz grains, and is very similar in its lithologic characters to some portions of the Wenonah sand, from which formation it is quite probable that the specimen was collected.

Formation and locality.—Wenonah sand (?), Marlboro. (Whitfield.)

Geographic distribution.—New Jersey.

Genus PERIPLOMYA Schumacher.

Periplomya elliptica, (Gabb).

Plate LVII., Figs. 8–11.

1861. *Anatina elliptica* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 324.
1864. *Anatina elliptica* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 15.
1868. *Anatina elliptica* Con., Cook's Geol. N. J., p. 727.
1876. *Periplomya elliptica* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 305.
1886. *Periplomya elliptica* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 177, pl. 23, figs. 14-15.
1886. *Periplomya truncata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 220, pl. 28, figs. 20-21.
1886. *Veleda nasuta* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 217, pl. 28, fig. 23.
1905. *Periploma elliptica* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 13.

Description.—"Shell small, inequivalve, and very inequilateral, subovate in outline, largest across the anterior side of the beaks, and strongly constricted just behind them, the posterior end being narrowed on the hinge-line and excavated at this point. Valves somewhat ventricose, the right one less convex than the left, and very decidedly depressed in the central region and toward the basal line, showing a decided twist or arcuation of the valves as seen in a basal view. Anterior end broadly rounded, and the posterior pointedly rounded. Beaks small, appressed, incurved, and apparently directed backward, as is usual in this group of shells, from the expansion or inflation of the anterior side of the hinge line. Cardinal margin, as seen on the cast, inflected both in front and behind the beaks, forming an apparent lunule and escutcheon on the cast, probably produced mainly from a thickening of the hinge-plate within. Muscular imprints and pallial line and hinge not observed." (Whitfield.)

The dimensions of the specimen illustrated by Whitfield are: length, 31 mm.; height, 27.5 mm.; thickness, 10 mm.

Remarks.—Whitfield records the specimen he has identified as *P. elliptica,* from the "Lower Green Marls at Mullica Hill and Holmdel" and the specimen which he has figured seems to have the lithologic features of the Navesink marl, although this cannot be asserted certainly because no locality is recorded with the species, and it might possibly be from the Manasquan marl. The type of the species, preserved in the collection of the Philadelphia Academy of Science is apparently from the Manasquan marl, judging from its lithologic characters. The types of the two species described by Whitfield as *P. truncata* and *Veleda nasuta* are both from the Manasquan, and both are clearly identical with the type of *P. elliptica.*

The species has not been met with in the recent collections of the Survey, and until authentic specimens are found elsewhere, the species may be considered as restricted in its range to the Manasquan.

Formation and locality.—Manasquan marl, near Mullica Hill ? and near New Egypt (Whitfield).

Geographic distribution.—New Jersey.

Genus Corimya Agassiz.

Corimya tenuis Whitfield.

Plate LVII., Figs. 16–18.

1886. *Corimya tenuis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 170, pl. 23, figs. 9-11.

Description.—The dimensions of a nearly perfect internal cast are: length, 32.5 mm.; height, 22 mm.; thickness, 10 mm.; the length of the largest specimen observed is 37 mm. Shell subelliptical to broadly triangularly ovate in outline; the valves unequally depressed convex, the right valve flatter than the left. Beaks small, little elevated above the hinge-line, nearly central in position. Anterior and posterior cardinal margins sloping away from the beak in a broadly obtuse angle; anterior and posterior margins rounded, the anterior higher than the posterior; basal margin broadly convex. Surface of the casts marked by more or less indistinct and irregular concentric undulations, and in some specimens by faint radiating ribs on the anterior slope of the shell. In the central portion of the casts, beneath the beak and extending further posteriorly than anteriorly, wavy vascular impressions can often be seen extending about half way to the ventral margin of the shell. Muscular impressions of moderate size, the posterior ones more conspicuous than the anterior, and bordered in front by a rather deep groove in the casts extending obliquely backward from behind the beak towards the posterior margin.

Remarks.—This species can be easily recognized by the unequal convexity of the valves which give to the specimens a slightly bent form, and by the conspicuous oblique furrow in front of the posterior muscular scars in the casts, which in the interior of the shells themselves was a ridge-like thickening of the valve. The species has only been observed in the form of internal casts and the external surface markings are not known.

Formation and locality.—Marshalltown clay-marl, Marshalltown (Whitfield); Navesink marl, Atlantic Highlands (108), near Crawfords Corner (126[7]), Crosswicks Creek (195), Mullica Hill (169), Upper Freehold (Whitfield).

Geographic distribution.—New Jersey.

Super-family ENSIPHONACEA.

Family CLAVAGELLIDAE.

Genus CLAVAGELLA Lamark.

Clavagella armata Morton.

Plate LVIII., Figs. 1–2.

1834. *Clavagella armata* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 69, pl. 9, fig. 11.
1861. *Clavagella armata* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 364.
1861. *Clavagella armata* Gabb, Synop. Moll. Cret. Form., p. 165 (109).
1864. *Clavigella armata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 15.
1886. *Clavagella armata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 192, pl. 25, fig. 24.

Description.—The dimensions of a complete internal cast of the shell, exclusive of the tube, are: length, 14 mm.; height, 8.5 mm.; thickness, 7.5 mm. Shell subovate in outline; the beaks small, situated a little in front of the middle, slightly recurved. Anterior and posterior margins rather sharply rounded; ventral margin convex throughout. The anterior margin with several tubular spines. Valves rather strongly convex, the right one free, the left one attached to the tube. Surface of the cast smooth, the muscular impressions more or less strongly marked, sometimes scarcely distinguishable.

Remarks.—Specimens of this peculiar species are rare in the New Jersey collections, and have been recognized only in the Navesink marl. The peculiar tubular spines which arm the anterior margin of the shell have sometimes been broken from the fossil specimens as is the case with the specimen illustrated by Whitfield. One specimen has been observed, however, upon which they are as clearly shown as upon the type specimen illustrated by Morton. The tube, except its very basal portion, is rarely preserved.

Formation and locality.—Navesink marl, Atlantic Highlands (108), near Crawfords Corner (126[7]), near Walnford (Whitfield), near Arneytown (Morton).

Geographic distribution.—New Jersey.

Super-family POROMYACEA.

Family POROMYACIDAE.

Genus LIOPISTHA Meek.

Liopistha protexta (Conrad).

Plate LVIII., Figs. 4-6.

1853. *Cardium protextum* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 2, p. 275, pl. 24, fig. 12.
1860. *Fragilia protexta* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 275.
1861. *Papyridea elegantula* Gabb, Synop. Moll. Cret. Form., pp. 164, 218 (108, 162).
1864. *Papyridea* (*Liopistha*) *protexta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 12.
1868. *Liopistha protexta* Con., Cook's Geol. N. J., p. 726.
1875. *Liopistha protexta* Con., Kerr's Geol. N. Car., App. p. 28.
1876. *Liopistha protexta* Meek, Inv. Cret. and Ter. Foss. Up. Mo., p. 227, text figures 20-24.
1886. *Leiopistha protexta* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 140, pl. 20, figs. 1-3.
1886. *Leiopistha inflata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 142, pl. 20, figs. 6-7.
1905. *Leiopistha protexta* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 13.

Description.—The dimensions of a large individual are: length, 30.5 mm.; height, 22 mm.; thickness, 16.5 mm. Shell, exclusive of the projecting beaks, subelliptical in outline. Beaks prominent, situated a little in advance of the middle of the shell, their apices pointed, incurved and nearly in contact. Antero-cardinal slope slightly concave; anterior margin sharply rounded; basal margin regularly convex throughout; posterior

margin rather short, obliquely subtruncate, straight or slightly convex; posterior cardinal slope more concave than the anterior. Valves ventricose in the umbonal region, the surface curving regularly to the margin all around, being more abrupt to the cardinal margin, and often somewhat compressed towards the postero-cardinal extremity; slightly gaping behind. Surface marked by 25 to 30, and in very large individuals as many as 35, angular, radiating costæ with concave interspaces, a small area at the posterior extremity being nearly or wholly destitute of ribs. External impressions of the shell show these ribs to be crossed by fine concentric lines of growth, and to be surmounted along the summit by a row of small tubercles appearing almost like spine bases, whose distance apart is less than the distance between adjacent costæ; the radiating rows of tubercles also continue across the posterior noncostate portion of the shell.

Remarks.—This is the commonest member of the genus in New Jersey and occurs, so far as known, only in the form of internal casts with their external impressions. The delicate surface markings of the shell can only be seen in impressions of the external surface, and only occasionally in these because of the imperfection of their preservation. Whitfield's *L. inflata* is certainly a synonym of this species; it is said to be shorter, with more inflated beaks, and less sharply defined costæ, but these differences are nothing more than individual variations.

Formation and locality.—Wenonah sand, near Marlboro (130); Navesink marl, Atlantic Highlands (108), near Crawfords Corner (126[7]), near Walnford (148[2], 149), Crosswicks Creek (195), Mullica Hill (169); Red Bank Sand, near Middletown (112), Red Bank (116), Shrewsbury River (119); Tinton beds, Beers Hills cut, south of Keyport (129[5]).

Geographic distribution.—New Jersey, Alabama, Mississippi, Arkansas, Texas.

Liopistha alternata n. sp.

Plate LVIII., Figs. 7–9.

Description.—The dimensions of an average left valve are: length, 22 mm.; height, 15.5 mm.; convexity, 7 mm. Shell,

exclusive of the projecting beaks, subelliptical in outline. Beaks central, or in some specimens apparently a little back of the center, their apices pointed, elevated above the hinge-line, strongly incurved and nearly or quite in contact. Antero-cardinal slope slightly concave or nearly straight; anterior margin rather sharply rounded; basal margin broadly and regularly convex; posterior margin rather sharply rounded above to the posterior extremity of the hinge-line; post-cardinal slope more concave than the anterior. Valves ventricose or inflated in the umbonal region, the surface curving abruptly to the cardinal margin, convex to the anterior and ventral margins, more or less compressed to the postero-cardinal extremity; slightly gaping posteriorly. Surface marked with 40 or more angular, radiating costæ in adult shells, the alternate ones being conspicuously larger. The smaller costæ are intercalated between the larger ones and do not reach the beak, so that in very young shells the alternation of costæ does not exist; upon the posterior, more or less compressed portion of the valves the costæ are nearly or quite obsolete. Distinct impressions of the external surface of the shells, show them to be marked by fine, indistinct lines of growth; they also show each costa, both the larger ones and the smaller ones, to be surmounted by a row of fine tubercles or short spines, whose distance apart is less than the spaces between the costæ, the radiating lines of tubercles are also present upon the posterior non-costate portion of the shell.

Remarks.—This species can be easily distinguished from *L. protexta* by the alternating costæ and the more central position of the beaks. These two species have never been observed associated in the same fauna, *L. alternata* being characteristic of the Merchantville, while *L. protexta* is especially characteristic of the Navesink.

Formation and locality.—Merchantville clay-marl, near Matawan (100[4], 101), near Jamesburg (139, 140).

Geographic distribution.—New Jersey.

Liopistha kümmeli n. sp.

Plate LVIII., Fig. 3.

Description.—The dimensions of a large right valve are: length, 21 mm.; height, 15 mm.; convexity, 4.5 mm. Shell subovate in outline, beaks central or a little in advance of the center, strongly incurved; antero-cardinal margin curving gently downward anteriorly from beneath the beak and passing regularly into the broadly rounded anterior margin; basal margin broadly rounded, becoming straighter posteriorly and sloping upward to the most posterior extremity of the shell which is above the mid-height; posterior extremity rather sharply rounded into the post-cardinal margin which is straight and horizontal. Surface marked by about 20, simple, subangular, radiating costæ, subequal in size, but becoming somewhat smaller anteriorly; upon the cardinal slopes the costæ become much fainter or even obsolete, the smooth area being broader behind than in front; upon the umbo and towards the beak, more or less faint concentric undulations cross the radiating ribs, but these become obsolete before reaching the middle of the shell in adult examples; impressions of the exterior show in addition to the radial and concentric markings already described, fine concentric lines of growth.

Remarks.—This species differs from *L. alternata* which occurs in the same horizon, in the absence of the alternating costæ, and in the presence of the concentric undulations towards the beak. It agrees more nearly with *L. protexta* from the Navesink marl, but the radiating costæ are coarser and less numerous, and that species also lacks the concentric undulations. In the presence of these concentric undulations, the species approaches the members of the genus *Cymella* in which the concentric markings are more conspicuous than the radial, but the much stronger radial markings suggests a closer relationship to the members of the genus *Liopistha*.

Formation and locality.—Merchantville clay-marl, near Jamesburg (139), Lenola (163).

Geographic distribution.—New Jersey.

Genus CYMELLA Meek.

Cymella bella Conrad.

Plate LVIII., Figs. 10–12.

1875. *Cymella bella* Con., Kerr's Geol. N. Car., App., p. 10, pl. 2, fig. 9.
1876. *Cymella bella* Meek, Rep. Inv. Cret. and Tert. Foss. Up. Mo., p. 228, text figs. 25-30.
1877. *Leiopistha (Cymella) meeki* Whitf., Prelim. Rep. Pal. Black Hills, p. 35.
1880. *Leiopistha (Cymella) meeki* Whitf., Rep. Geol. and Res. Black Hills of Dak., p. 418, pl. 11, figs. 27-28.
1886. *Cymella meeki* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 142, pl. 20, figs. 6-7.

Description.—"Shell of moderate size, transversely oval or ovate, about once and a half as long as high. Valves strongly convex, with large, somewhat prominent beaks, situated much nearer the anterior end. Shell nearly erect, and a little wider at the anterior end than behind. Extremities of the valves nearly equally rounded and the base regularly curved. Cardinal line long behind the beaks, and the margin inflected forming a narrow, linear, escutcheon-like area. Surface of the shell marked by strong and regularly rounded and regularly increasing undulations parallel to the border of the valves. These are crossed by distant radiating ribs, which are strong and vertical in the middle of the valve or opposite the beaks, and become gradually fainter and finer toward the posterior end, apparently becoming obsolete just below the cardinal border, and also before reaching the anterior cardinal margin. These radiating ribs, on the central parts of the shell especially, cut up the surface into rounded nodes by forming depressions across the concentric undulations. Surface of the shell and hinge-structure not seen, as the specimens are all in the condition of casts in a fine micaceous marl." (Whitfield.)

The dimensions of a large left valve are: length, 41 mm.; height, 27.5 mm., convexity, 9.5 mm.

Remarks.—There seems to be no sufficient reason for separating these New Jersey shells from *Cymella bella* Con., although Whitfield has established the species *C. meeki* for certain Black Hills examples, to which species he has referred the New Jersey specimens. The distinctive character of *C. meeki,* as indicated by Whitfield, is in the presence of the radiating ribs over the entire surface of the shell, while in *C. bella,* according to the original illustration of the species, they are restricted to the central portion of the shell. In all the specimens of this shell in the recent collections of the Survey, these ribs are most strongly developed on the central portion of the shell, becoming fainter both posteriorly and anteriorly; in most instances the anterior portion of the shell is entirely destitute of the ribs while faint indications of them continue nearly to the post-cardinal border. Although this distribution of the radiating ribs is quite different from Conrad's illustration of *C. bella,* in his description of that species he says "disk sculptured with concentric furrows and acute radiating ribs interrupted at the furrows, anterior side nearly or quite destitute of radii and occasionally exhibiting minute raised points." This description fits the New Jersey specimens exactly, and it is highly probable that the original figure is not a fair illustration of the species. The Cliffwood clay specimens from New Jersey resemble the original figure of *C. bella* more closely than those from the higher formations, but all, including also the Black Hills specimens of Whitfield, should doubtless be referred to a single species, *C. bella.*

Formation and locality.—Cliffwood clay, near Matawan (107); Merchantville clay-marl, near Matawan (101); Woodbury clay, Lorillard (102), near Matawan (103), near Haddonfield (165); Wenonah sand, near Marlboro (130[1]).

Geographic distribution.—New Jersey, North Carolina, Texas, Arkansas, South Dakota.

Cymella undata (Meek and Hayden).

Plate LVIII., Fig. 13.

1856. *Pholadomya undata* M. & H., Proc. Acad. Nat. Sci. Phil. (1856), p. 81.

1864. *Pholadomya* (*Cymella*) *undata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., pp. 14 and 34.

1876. *Liopistha* (*Cymella*) *undata* Meek, Rep. Inv. Cret. and Ter. Foss. Up. Mo., p. 236, pl. 30, figs. 1a-1b.

Description.—"Shell transversely broad-ovate, approaching subtrigonal, moderately gibbous; anterior end rounded; posterior side narrower and a little more compressed, rounded chiefly from below; base forming a regular semiovate curve; dorsal margin sloping rather abruptly in front of the beaks, straighter and declining more gradually behind; hinge-margins straight, and inflected so as to form a well-defined false area both behind and a little in front of the beaks, which are somewhat elevated, incurved at right angles to the hinge-line, and located a little in advance of the middle of the shell. Surface ornamented by about 17 to 20 of the simple, rounded, rather strong, regular, concentric undulations, which are broader than the depressions between, and, as it were, cut by the radiating linear furrows, on the central region of each valve, into about the same number of much smaller, simple, radiating costæ, less than, or nearly equaling, the furrows by which they are separated." (Meek.)

The dimensions of the only specimen observed, a left valve, are: length, 16.5 mm.; height, 12 mm.; convexity, 3.5 mm.

Remarks.—This species is represented in the New Jersey collections by a single individual which agrees very closely with Meek's description and illustration of the species. In only one respect is there any marked difference, and that probably not essential, the number of fine radiating, linear furrows being greater and occupying a wider space on the central portion of the shell. About 30 of these furrows can be clearly distinguished and exceedingly faint ones seem to extend still further towards the posterior and anterior extremities. The shell is associated with *C. bella,* but is clearly distinct from it by reason of the much finer radiating markings, and there are no intermediate forms connecting the two species.

Formation and locality.—Wenonah sand, near Marlboro (130[1]).

Geographic distribution.—New Jersey, South Dakota.

Family CUSPIDARIIDAE.

Genus CUSPIDARIA Nardo.

Cuspidaria ventricosa (Meek and Hayden).

Plate LVIII., Figs. 16–17.

1856. *Corbula ventricosa* M. & H., Proc. Acad. Nat. Sci. Phil., vol. 8, p. 83.
1860. *Neæra ventricosa* M. & H., Proc. Acad. Nat. Sci. Phil., vol. 12, p. 185.
1861. *Neaera ventricosa* Gabb, Synop. Moll. Cret. Form., p. 204.
1864. *Neæra ventricosa* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 15.
1876. *Neæra ventricosa* Meek, Rep. on Inv. Cret. and Ter. Foss. Up. Mo., p. 238, pl. 30, figs. 3 a-e.

Description.—"Shell small, nearly or quite equivalve, rather thin, very ventricose in the anterior and central regions; anterior margin somewhat narrowly rounded; base very deeply rounded toward the front, contracted behind; posterior side longer than the other, narrow, compressed and rostriform; dorsum sloping gradually with a concave outline behind the beaks, declining more abruptly in front; beaks prominent, apparently equal not oblique, located a little in advance of the middle; pallial border smooth; surface marked by rather concentric striæ." (Meek.)

The dimensions of a single valve are: length, 13 mm.; height, 7 mm.; convexity, 2.7 mm.

Remarks.—All the examples of this species observed in New Jersey are casts, and these have frequently been more or less distorted in the soft clays and sands where they occur. The form and size of the shell, however, agrees well with those described by Meek from the Fox Hills and Pierre faunas of the west, and there can be no doubt as to their identity.

Formation and locality.—Wenonah sand, near Marlboro (130[1]); Red Bank sand, Red Bank (116), Shrewsbury River (119), near Middletown (112); Tinton beds, Beers Hill cut (129[5]).

Geographic distribution.—New Jersey, South Dakota.

Cuspidaria jerseyensis n. sp.

Plate LVIII., Figs. 14–15.

Description.—Shell large for the genus, the dimensions of the type specimen being: length, 25.5 mm.; height, 17 mm.; thickness, 13.7 mm. Ventricose in the anterior and central region, compressed and rostriform posteriorly; the beaks incurved, directed backward, situated centrally, the right one a little in advance of the left. From the beaks the anterior margin slopes gently downward in front, passing into the broadly rounded anterior margin, which in turn passes without interruption into the basal margin which is gently rounded anteriorly, becoming straighter posteriorly as it slopes upward to meet the cardinal margin in an obscure acute angle, the posterior margin restricted to the sharply rounded rostrate extremity of the shell, the post-cardinal margin concave just behind the beaks, becoming straight posteriorly. Surface of the internal cast marked by regular, rounded, concentric undulations a little less than one millimeter apart, and by very obscure radiating lines.

Remarks.—This species is based upon a single nearly complete internal cast from New Jersey and a second less perfect specimen from Alabama. The species differs from *C. ventricosa,* in its larger size, its more nearly central beaks, and in its concentric markings.

Formation and locality.—Navesink marl, near Crawfords Corner (126[7]).

Geographic distribution.—New Jersey, Alabama.

Order TELEODESMACEA.

Super-family CYPRICARDIACEA.

Family PLEUROPHORIDAE.

Genus VENIELLA Stoliczka.

Veniella conradi (Morton).

Plate LVIII., Figs. 18–19.

1833. *Venilia conradi* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 294, pl. 8, figs. 1-2.

1834. *Venilia conradi* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 67, pl. 8, figs. 1-2.
1861. *Venilia conradi* Gabb, Synop. Moll. Cret. Form., p. 233 (177).
1864. *Venilia conradi* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 13.
1868. *Venilia conradi* Con., Cook's Geol. N. J., p. 727.
1869. *Goniosoma inflata* Con., Am. Jour. Conch., vol. 5, p. 44, pl. 1, fig. 10.
1870. *Venilia elevata* Con., Am. Jour. Conch., vol. 6, p. 74, pl. 3, figs. 7-7a.
1876. *Veniella conradi* Meek, Rep. Inv. Cret. and Tert. Foss. Up. Mo., p. 148, text figs. 9-11.
1886. *Veniella conradi* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 144, pl. 19, figs. 8-10.
1886. *Veniella inflata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 147, pl. 19, figs. 4-5.
1886. *Veniella elevata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 148, pl. 19, figs. 6-7.
1905. *Veniella conradi* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 13.
1905. *Veniella elevata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 13.
1905. *Veniella inflata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 13.

Description.—The dimensions of an average sized left valve are: length, 26 mm.; height, 23 mm.; convexity, 12 mm. Shell subtrapezoidal in outline. Hinge-line rather strongly curved. Anterior margin straight above, sloping obliquely forward, sharply rounding into the basal margin below; basal margin gently convex, becoming straighter posteriorly; postero-basal extremity angular; posterior margin obliquely truncate; postero-cardinal extremity obtusely angular, becoming rounder in the larger individuals; postero-cardinal margin rather long, straight or slightly convex. Valves very ventricose, with a sharply angular, curved umbonal ridge. Beaks situated nearly as far

front as the anterior extremity of the shell, incurved and directed forward. Post-umbonal slope abrupt, with a shallow sinus extending from the beak to the posterior margin of the shell, and a low subangular ridge curving from the beak to the postero-cardinal extremity; anterior slope convex from the umbonal ridge forward, the curvature of the surface becoming much more abrupt as it approaches the anterior margin. Surface of the shell marked by several, strong, concentric varices which become more remote away from the beak, and upon very large individuals become obsolete upon the outer portion of the shell; they are produced into broad, lamellar extensions of the shell and do not continue across the post-umbonal slope. The shell surface is also marked by more or less irregular concentric lines of growth.

Remarks.—This is one of the long range species in the New Jersey faunas, and is liable to occur at any horizon from the Merchantville to the Tinton. The species does not usually attain so large a size in New Jersey as it sometimes does in some of the southern localities, although individuals 30 mm. in height are sometimes met with. The little shell from Haddonfield described by Conrad as *V. elevata* is only a young individual of *V. conradi,* and the same author's *Goniosomo inflata* is an internal cast of the same. The species occurs most abundantly in the Merchantville, Marshalltown, and Wenonah formations, being rare in the Woodbury. The only place where the shells themselves have been collected in the State is from the Marshalltown clay-marl near Swedesboro.

Formation and locality.—Merchhantville clay-marl, near Jamesburg (139, 140, 141), Merchantville (162), Lenola (163); Wenonah sand, near Marlboro (130[1]), near Crawfords Corner (126[3]); Navesink marl, Atlantic Highlands (108), near Crawfords Corner (126[7]), near Walnford (149), Mullica Hill (169[2]); Red Bank sand, Red Bank (116), Shrewsbury River (199), near Middletown (112); Tinton beds, Beers Hill cut, south of Keyport (129[5]).

Geographic distribution.—New Jersey, Alabama, Mississippi.

Veniella trigona (Gabb).

Plate LIX., Figs. 1–3.

1861. *Venilia trigona* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 324.
1864. *Venilia trigona* Meek, Check List. Inv. Foss. N. A., Cret. and Jur., p. 13.
1868. *Venilia trigona* Con., Cook's Geol. N. J., p. 727.
1886. *Veniella trigona* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 149, pl. 19, figs. 11-14.
1905. *Veniella trigona* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 13.

Description.—The dimensions of a nearly complete left valve are: length, 58 mm.; height, 51 mm.; convexity, 25 mm. Shell subtrigonal in outline. Hinge-line strongly curved; anterior margin sharply rounding into the basal margin; basal margin convex in front, becoming straight or slightly concave posteriorly; postero-basal extremity angular; posterior margin truncate, rounding above into the long, convex post-cardinal margin. Valves very ventricose with a sharply angular, strongly curved umbonal ridge. Beaks extending as far forward as the anterior margin of the shell, strongly incurved. Post-umbonal slope abrupt, becoming less so posteriorly, divided by an obtusely subangular ridge which originates back of the beak and describes a curve to the post-cardinal extremity; the area between the umbonal and cardinal ridges is slightly concave, and is much broader than the area between the cardinal ridge and the cardinal margin. Anterior slope with a slight sinuosity just in front of the umbonal ridge in the lower portion of the shell; in front of this the surface is convex, becoming more abrupt anteriorly and being somewhat inflected to the antero-cardinal margin beneath the beak. Shell substance very thick. Surface of the shell rugosely marked with irregular concentric lines of growth and with rather broad, wrinkle-like ridges; towards the beak there is some evidence of two or more lamellar ridges as in *V. conradi.* The strong rugosities do not extend across the post-cardinal slope of the shell, this portion being marked only by the irregular lines of growth. In the casts the beaks are straighter, much less

incurved, and do not extend as far forward as the extreme anterior margin of the shell. The strong concentric rugosities of the shell are not impressed upon the surface of the casts, but the muscular impressions are large and strong, the anterior one especially being much elevated above the general surface of the cast, indicating the presence of a very deeply impressed anterior muscular attachment.

Remarks.—There seems to be nothing about this shell which might not be an extreme condition of the much smaller *V. conradi.* The external characters have been described above from a plaster cast taken from a very perfect mould of the outside of a large shell of which the internal cast is also perfectly preserved. A portion taken from the apical part of the shell of the size of the ordinary specimens of *V. conradi* from the lower beds, could not be distinguished from members of that species. It has been thought best to retain *V. trigona* as a distinct species, however, because of its stratigraphic relations, it being nowhere observed in beds beneath the Navesink marl. In the lower beds, shells with the characters of *V. conradi* seem to be fully adult, and do not seem to develop further, but in the higher beds we find *V. trigona* a direct genetic successor of *V. conradi,* the development of whose shell continues much further than the shell of the earlier form. It is possible that the specimens from the higher beds which have been identified as *V. conradi,* should rather be considered as the young of *V. trigona,* since it would be difficult or perhaps impossible to distinguish between the young of the later and the adults of the earlier species.

Formation and locality.—Navesink marl, near Walnford (147[4], 148[4], 149); Tinton beds, Beers Hill cut, south of Keyport (129[5]).

Geographic distribution.—New Jersey, Alabama, Texas.

Veniella ? rhomboidea Conrad.

Plate LVIII., Figs. 22–24.

1853. *Venilia ? rhomboidea* Con., Jour. Acad. Nat. Sci. Phil. 2d ser., vol. 2, p. 275, pl. 24, fig. 7.

1861. *Venilia rhomboidea* Gabb, Synop. Moll. Cret. Form., p. 234 (178).

1864. *Venilia rhomboidea* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 13.
1868. *Venilia rhomboidea* Con., Cook's Geol. N. J., p. 727.
1886. *Veniella rhomboidea* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 215, pl. 28, figs. 12-13.
1905. *Veniella rhomboidea* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 14.

Description.—The dimensions of a nearly perfect internal cast are: length, 19 mm.; height, 15 mm.; thickness, 14 mm. Shell trapezoidal or subrhomboidal in outline. The beaks situated near the anterior margin, strongly incurved and directed forward. Anterior margin short, sharply rounded; ventral margin nearly straight, usually slightly convex anteriorly and straight or slightly concave posteriorly; postero-basal extremity sharply angular; posterior margin obliquely truncate, higher than the anterior margin; post-cardinal margin sloping gently backward from the beak, slightly convex, becoming straighter posteriorly; posterior cardinal extremity obtusely angular. Valves strongly ventricose with a prominent, sharply angular, curved umbonal ridge; posterior slope abrupt, concave, abruptly inflected to the cardinal margin; anterior slope gently convex or nearly flat across the middle of the shell, sometimes with a slight sinus towards the ventral margin just in front of the umbonal ridge; anteriorly it curves abruptly downward to the anterior margin, and is inflected below the beaks. Surface of the casts marked by a few inconspicuous concentric lines of growth; the muscular impressions faint, the posterior ones scarcely or not at all distinguishable upon the casts; at the dorsal margin of the anterior muscular impression is a ridge-like thickening of the shell which, in the casts, appears as a distinct groove or furrow crossing the hinge-line just beneath and in front of the beaks.

Remarks. This species has always been considered as a member of the genus *Veniella,* and the shell does have a superficial resemblance to members of that genus. The hinge-characters, however, have not been observed, and without these the true generic relations of the species cannot be determined. One peculiar character of these casts which is certainly different from any

true members of the genus *Veniella,* is the internal, transverse, ridge-like thickening of the shell at the dorsal margin of the anterior muscular impression, a character which is probably of generic value and which is present also in the cast identified by Whitfield as *V. decisa.* Both these species have strongly enrolled beaks, a character in which they simulate members of the genus *Isocardia,* and they resemble, both in their general form, their strongly enrolled beaks, and in the transverse thickening of the shell mentioned above, a shell which is described by Wood as *Isoarca agassizii*[1] P. & R., from the Cretaceous of England. It is possible that they should be referred to the genus *Isoarca,* but they show no evidence of having had any Arca-like teeth, and before so referring them they should be carefully compared with the type of that genus.

Formation and locality.—Manasquan marl, near New Egypt, Farmingdale.

Geographic distribution.—New Jersey.

Veniella ? decisa (Morton).

Plate LVIII., Figs. 25–26.

1833. *Cardita decisa* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 292; vol. 24, pl. 9, fig. 3.
1834. *Cardita decisa* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 66, pl. 9, fig. 3.
1861. *Cardita decisa* Gabb, Synop. Moll. Cret. Form., p. 160 (104).
1886. *Veniella decisa* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 145, pl. 19, figs. 15-16.

Description.—"Shell of medium size, subquadrangular, rhomboidal or triangularly rhombic in outline, dependent more or less on compression or distortion of the valves. Valves usually very ventricose, with strong, rather inflated and enrolled beaks, situated near the anterior end and curved anteriorly, and strongly angular on the back; umbonal ridge distinctly and prominently

[1] Monog. Cret. Lam. Eng., p. 65, pl. 13, figs. 7 a-b.

angular, and highly arcuate in its passage from the beaks to the postero-basal angle of the valves. Cardinal border arcuate, the cardinal and basal margins subparallel and nearly equally curved; posterior margin squarely truncate below and sloping toward the hinge-line above; anterior end sharply rounded, and deeply excavated beneath the beaks. Postero-cardinal slope rather abrupt. Surface of the shell, as indicated on the casts, smooth or marked only by concentric lines of growth." (Whitfield.)

Remarks.—Morton's type of this species has apparently been lost or destroyed, and it has usually been the custom to consider the species as a synonym of *V. conradi.* Whitfield, however, has revived Morton's name, applying it to certain specimens which, from the locality given, probably occur in the Hornerstown marl, but this can not be asserted with certainty because the form has not been met with in the recent collections, and it is not certain that the specimens used by Whitfield are specifically identical with Morton's type. In its generic characters this species, as interpreted by Whitfield, is evidently related to *Veniella rhomboidea,* and as has been pointed out under the discussion of that species, both should perhaps be referred to the genus *Isoarca.*

Formation and locality.—Hornerstown marl ?, Blue Ball, and near Mullica Hill (Whitfield).

Geographic distribution.—New Jersey.

Genus ETEA Conrad.

Etea carolinensis Conrad.

Plate LIX., Figs. 4-6.

1875. *Etea carolinensis* Con., Kerr's Geol. N. Car., App. p. 6, pl. 1, fig. 14.

1905. *Etea carolinensis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 14.

Description.—The dimensions of a shell of average size, preserving both valves, are: length, 33 mm.; height, 22.5 mm.;

thickness, 14 mm. Length of the largest individual observed, 14 mm. Shell very oblique and inequilateral, the beaks obtuse, slightly incurved, situated about three-eights of the entire length of the shell from the anterior extremity. Anterior margin somewhat narrowly rounded and passing into the basal margin; basal margin moderately convex anteriorly, becoming straight or usually slightly concave posteriorly; posterior-basal extremity acutely angular; posterior margin rather short, obliquely truncate; postero-dorsal margin straight except near the beak where it becomes slightly convex, making an angle of about 136° with the truncate posterior margin. Surface of the shell marked with a sharply angular or subcarinate, usually straight, umbonal ridge passing from the beak to the postero-basal extremity of the shell; postero-dorsal slope concave from the umbonal ridge to the cardinal margin, where the shell is sharply inflected to form a large and nearly flat escutcheon; in front of the umbonal ridge a broad, more or less indefinite depression passes from the beak to the sinuosity in the posterior portion of the ventral margin; in front of the beak the surface is inflected to form a rather large and broad lunule. Entire surface of the shell covered with strong, concentric lines of growth, which are more or less irregular in the strength of their development. Hinge of right valve with a large bifid cardinal tooth directed obliquely backwards from beneath the beak, and a much smaller simple one directed forward; between these two teeth is a deep triangular pit, and behind the posterior one is a much narrower pit; two large lateral teeth are present, one in front and one behind the beak, the anterior one is nearer the beak with a broad and deep pit between it and the hinge-line, the posterior one is more elongate and slender, and is also separated from the hinge-line by a deep pit. The hinge of the left valve has two cardinal teeth, a large bifid one immediately beneath the beak and a thin, very oblique one behind, with a large, oblique, triangular pit between the two; there are two strong lateral teeth, one in front and one behind, the anterior one being nearer the beak and usually stronger but not so much extended longitudinally as the posterior one. Muscular impres-

sions large and strong, of about equal size; pallial line parallel with the truncated posterior margin for a short distance below the posterior muscular impression, then bending abruptly forward and continuing subparallel with the shell margin.

Remarks.—This species occurs abundantly in the Marshalltown clay-marl near Swedesboro, where it is preserved with the shell in perfect condition. These specimens differ somewhat from the original illustration of the species, but they have been compared with authentic examples in the National Museum, from the type locality at Snow Hill, North Carolina, and they seem to be specifically the same. Among the Snow Hill Material studied there are two somewhat different forms one of which is essentially identical with the Swedesboro specimens, while the other is a smoother shell in which the strong concentric growth lines are absent and in which the basal margin is convex throughout. Conrad's figure of the type specimen is nearly intermediate in its characters between these two forms, but all should doubtless be included in one species. The Swedesboro examples differ chiefly from the North Carolina ones in exhibiting a less wide range of individual variation. The species differs from *E. trapezoidea* in being somewhat more elongate, with the posterior, obliquely truncate margin shorter, so that the postero-basal extremity is lower down.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177).

Geographic distribution.—New Jersey, North Carolina.

Etea trapezoidea (Conrad).

Plate LVIII., Figs. 20–21. Plate LIX., Fig. 7.

1860. *Venilia trapezoidea* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 282, pl. 47, fig. 7.

1860. *Crassatella Monmouthensis* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 302, pl. 48, fig. 19.

1861. *Crassatella Monmouthensis* Gabb, Synop. Moll. Cret. Form., p. 168 (112).

1861. *Venilia trapezoidea* Gabb, Synop. Moll. Cret. Form., p. 234 (178).

1862. *Crassatella lineata* Shum., Proc. Bost. Soc. Nat. Hist., vol. 8, p. 201.
1864. *Crassatella monmouthensis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 11.
1864. *Venilia trapezoidea* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 13.
1868. *Crassatella Monmouthensis* Con., Cook's Geol. N. J., p. 726.
1868. *Venilia trapezoidea* Con., Cook's Geol. N. J., p. 727.
1876. *Etea monmouthensis* Con., Proc. Acad. Nat. Sci. Phil. (1876), p. 275.
1886. *Crassatella Monmouthensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 119, pl. 17, figs. 21-22.
1886. *Veniella subovalis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 150, pl. 19, figs. 1-2.
1886. *Veniella trapezoidea* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 151, pl. 19, fig. 3.
1905. *Crassatellites monmouthensis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 14.
1905. *Veniella subovalis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 13.
1905. *Veniella trapezoidea* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 13.

Description.—The dimensions of an average specimen are: length, 26 mm.; height, 18 mm. The specimens sometimes attain a length of 30 mm. or more. Shell very oblique and inequilateral, subtrapezoidal to subelliptical in outline, the beaks situated about one-third the length of the shell from the anterior extremity. Anterior margin rounding into the basal margin; basal margin convex anteriorly and sometimes throughout, often somewhat gibbous in the middle, and usually slightly sinuate posteriorly; postero-basal extremity acutely subangular, posterior margin obliquely truncate, the postero-dorsal margin straight or slightly curved, sloping from the beak to the posterior hinge extremity, where it meets the truncated posterior margin in an obtuse angle. Valves with an angular or subcarinate umbonal ridge passing from the beak to the postero-ventral extremity of the shell; in

front of the umbonal ridge is a more or less obscure depression or broad shallow sinus, which passes obliquely backward from the beak to the sinuosity in the ventral margin. The postero-dorsal slope concave to the cardinal margin, where the surface is inflected to form the escutcheon. In front of the beak the surface of the shell is inflected to form the rather large lunule. In the casts the muscular impressions are of moderate size, inconspicuous or somewhat strongly marked, and the free margins are not crenate. Surface of the shell marked by concentric lines of growth which vary in the strength of their development.

Remarks.—This specific form seems to have been described under several names by different authors, Conrad's name *trapezoidea* having priority. The types of the species *Venilia trapezoidea, Crassatella monmouthensis* and *Veniella subovalis* have all been carefully studied in the collection of the Philadelphia Academy of Science. The specimens indicated as types of *C monmouthensis* are four in number; the smallest of these has "type" marked on it in ink, and seems to be different from the other three; it has the shell preserved, and from its lithologic character seems to have come from one of the marl beds, probably the Navesink; this smaller specimen is apparently not the one which was illustrated by Gabb. The three larger individuals agree with the original illustration of the species in all essential characters, and one of them was doubtless used as the original for the figure; these specimens apparently came from the Merchantville formation, and are identical with *V. trapezoidea* and with the Merchantville clay specimens in the recent collections of the Survey. Whitfield's *Veniella subovalis* is certainly a member of the same species, although its posterior margin is somewhat higher and more nearly vertical than the others. The type of *Crassatella lineata* has not been seen, but the species is represented in the National Museum at Washington by numerous examples from the type locality, and it is unquestionably specifically identical with the Alabama and New Jersey specimens. An examination of a large number of individuals of this species shows considerable variation in some respects, notably in the height of the posterior truncated margin, and in the curvature of the basal

margin, which is sometimes slightly sinuate posteriorly and again nearly straight or slightly convex. The species resembles *E. carolinensis,* but it is a shorter shell with a higher posterior margin; the two forms are certainly cogeneric, however, and if it is advisable to recognize *Etea* at all as distinct from *Veniella,* both should be placed in that genus.

Formation and locality.—Merchantville clay-marl, near Matawan (101), near Jamesburg (140, 141), Lenola (163), Merchantville (162).

Geographic distribution.—New Jersey, Alabama, Texas.

Etea delawarensis (Gabb).

Plate LIX., Figs. 8–9.

1860. *Crassatella Delawarensis* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 303, pl. 48, fig. 20.
1861. *Crassatella Delawarensis* Gabb, Synop. Moll. Cret. Form., p. 168 (112).
1864. *Crassatella delawarensis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 11.
1868. *Crussatella delawarensis* Cook, Geol. N. J., p. 376, figure.
1868. *Crassatella Delawarensis* Con., Cook's Geol. N. J., p. 726.
1876. *Etea Delawarensis* Con., Proc. Acad. Nat. Sci. Phil. (1876), p. 275.
1886. *Crassatella Delawarensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol .9), p. 210, pl. 27, figs. 14-15.
1905. *Crassatellites delawarensis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 14.

Description.—The dimensions of a nearly perfect specimen are: length, 26 mm.; height, 19.5 mm.; thickness, 12.5 mm. Shell cuneately subovate or subtriangular in outline, highest in front, the beaks elevated, rather small, incurved, situated between one-third and one-fourth the length of the shell from the anterior extremity. Antero-cardinal margin rather long, nearly straight or slightly concave, sloping steeply forward from the beaks; anterior margin rather narrowly rounding into the basal margin;

basal margin gently convex anteriorly and straight or slightly concave posteriorly; postero-basal extremity sharply rounded or subangular; posterior margin slightly convex, obliquely truncate; postero-cardinal margin long and straight, joining the posterior margin in an obtusely rounded angle. From the beak to the postero-basal angle, a rather broadly rounded umbonal ridge extends in a nearly straight line; the postero-cardinal slope is nearly flat posteriorly, becoming a little convex towards the beak; the cardinal margin is sharply inflected to form the sides of the narrow but rather deeply excavated escutcheon. In front of the umbonal ridge the shell is flattened or slightly sinuate from the beak obliquely backward to the basal margin; in front of the beak the shell is inflected along the cardinal margin to form the rather broad, concave lunule. Surface of the shell marked with moderately fine, but rather strong and regular concentric lines of growth, which become obsolescent back of the umbonal ridge.

In the internal casts the beaks are more prominent, erect and rather widely separate, the shell is rather more pointed posteriorly and the muscular and pallial impressions are of moderate strength.

Remarks.—There seems to be some uncertainty as to the origin of the type specimen of this species. In the original description it is said to be from the "Deep Cut, Delaware and Chesapeake Canal," which would make its horizon about that of the Merchantville clay-marl. This type specimen is preserved in the collection of the Philadelphia Academy of Science, and is labeled in Gabb's own hand-writing, "Crosswick's N. J.," according to Johnson, which would make its horizon the Woodbury clay. The species is a very characteristic one, and shows so little variation, that it is not possible to mistake it, and in all the collections made since the species was described, it has been found only in the Manasquan marl. It seems probable, therefore, that the type specimen also came from this formation, notwithstanding the fact that the original author of the species recorded it from elsewhere. The two different localities assigned to the specimen by Gabb would indicate some uncertainty as to its true origin in that author's own mind.

The species was placed in the genus *Etea* by Conrad, and although the hinge-structure has not been observed to demonstrate

its generic relations, it is retained in that genus here because it has the general form of authentic species of the genus, and agrees with them rather than with *Crassatellites* in the absence of crenulations upon the inner free margin of the shell.

Formation and locality.—Manasquan marl, Pemberton (191), near Farmingdale (138).

Geographic distribution.—New Jersey.

Genus AMBOCARDIA Whitfield.

Ambocardia cookii Whitfield.

Plate LX., Figs. 1–2.

1886. *Ambocardia cookii* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 25, pl. 2, figs. 11-14.

Description.—"Shell large and ponderous, with heavy, massive, incurved beaks, which are strongly enrolled and situated near the anterior end of the shell. Valves very gibbous, very inequilateral and transverse, strongly cuneate in a cardinal view when united, being extremely ventricose opposite the beaks and gradually but rapidly decreasing in depth toward the posterior end; obliquely ovate in outline, with a short, obtusely pointed anterior end, straight but short cardinal line; prolonged but obtusely rounded posterior end; basal line strongly curved, rapidly declining from the anterior end, and distinctly sinuate near the middle of the shell by a broad, shallow, but well-defined oblique sulcus, which passes from the beak to the basal margin just in front of the strongly rounded and prominent umbonal ridge. External ligament strongly marked, and extending the length of the posterior cardinal line and deeply imbedded in a narrow escutcheon. Lunule large and deep, strongly defined, with sharply angular margins. Substance of the shell thick and dense, and the surface marked with close comparatively strong concentric lines or ridges, and apparently with a thick epidermis. Anterior muscular scar large and deep, situated close to the margin in the pointed anterior end. Other muscular imprints not

determined and the features of the hinge are as yet unknown. Pallial line apparently simple." (Whitfield.)

Formation and locality.—Raritan clay, Sayreville, near Woodbridge, East Brunswick (Whitfield).

Geographic distribution.—New Jersey.

Super-family ASTARTACEA.

Family ASTARTIDAE.

Genus ASTARTE Sowerby.

Astarte veta Conrad.

Plate LX., Fig. 3.

1869. *Astarte veta* Con., Am. Jour. Conch., vol. 4, p. 279, pl. 20, fig. 4.
1870. *Astarte veta* Con., Am. Journ. Conch., vol. 5, p. 227.
1886. *Astarte veta* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 23, pl. 2, fig. 1.

Description.—"Mr. Conrad described this species as 'Ovate, from ventral margin to beak, compressed, equilateral; beaks prominent, oblique; anterior ventral margin rounded, posterior obliquely truncated; posterior end truncated and situated much above the line of the base (cast).' In comparison he says, 'this species is nearly allied to, if not identical with, *Astarte Triasina,* Dunker.'

"I have not been able to obtain specimens agreeing with the above description, nor to find the type specimen used by Mr. Conrad. The form of the shell would indicate that it belonged to the genus *Astarte,* but beyond that there appears to be no real evidence of its generic relations more than there is to other species found in these clays. The outline of the shell might suggest that it was a young individual of what I have herein called *Gnathodon tenuidens,* but the apparent want of gibbosity would not agree. So for the present at least the species will have to be left as it is." (Whitfield.)

Remarks.—This species has not been met with in recent investigations of the Survey and nothing can be added to Whitfield's discussion.

Formation and locality.—Raritan clay, near Washington (Conrad.)

Geographic distribution.—New Jersey.

Genus Eriphyla Gabb.

Eriphyla conradi (Whitfield).

Plate LX., Figs. 4–8.

1886. *Gouldia conradi* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 125, pl. 18, figs. 1-3.

1905. *Eriphyla conradi* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 14.

Description.—"Shell small, the largest specimen observed not exceeding three-sixteenths of an inch in its greatest diameter. Valves subtriangular, approaching a quadrangular outline by the truncation of the posterior extremity, which gives the valves when seen from the exterior much the form and character of a young *Crassatella,* which is also added to by their moderate convexity. Beaks small and pointed. Anterior and posterior sides of the cardinal margin straight, forming a little more than a right angle with each other, the posterior side being nearly one-half longer than the anterior, and the basal line somewhat regularly rounded. Surface of the shell marked by concentric undulations, which are abruptly bent in crossing the umbonal ridge. Posterior umbonal slope flattened. Lunule rather long and narrow. Substance of the shell thin. Ligamental pit of the hinge small in the left valve, and the posterior cardinal tooth-cavity linear and extending nearly the entire length of the cardinal border. In the right valve the pit is larger and the anterior lateral tooth-cavity more strongly marked. Muscular scars and pallial line distinctly marked in the right valve (figured), but much less strongly so in the left one, which is thinner in substance, although a slightly larger valve." (Whitfield.)

Remarks.—The specimens in the recent collections which have been identified with this species do not agree with the original description and illustration of the species as well as might be desired. They are usually larger shells with less elevated beaks and less markedly truncate posteriorly. All the specimens observed, however, are more or less imperfectly preserved.

Formation and locality.—Merchantville clay-marl, near Jamesburg (139, 140, 141), Lenola (163), Merchantville (162); Woodbury clay, near Matawan (103), Haddonfield (183).

Geographic distribution.—New Jersey.

Eriphyla decemnaria (Conrad).

Plate LX., Fig. 9.

1865. *Gouldia decemnaria* Con., Am. Jour. Conch., vol. 5, p. 48, pl. 9, fig. 4.

1886. *Gouldia decemnaria* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 124, pl. 18, fig. 4.

1905. *Eriphyla decemnaria* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 14.

Description.—"Shell minute, subquadrangular in outline and but slightly convex. Anterior and cardinal margins nearly at right angles with each other, the posterior and cardinal margins being rounded. Surface marked by very prominent, thickened, concentric ribs, parallel to the border of the valve, and separated by smooth, flattened interspaces. Hinge-structure and other internal characters unknown." (Whitfield.)

Remarks.—This species has not been met with in the recent collections of the Survey, and is known only from the type specimen, a little shell scarcely 2 mm. in height.

Formation and locality.—Woodbury clay, Haddonfield (183).

Geographic distribution.—New Jersey.

Eriphyla declivis (Conrad).

Plate LX., Fig. 10.

1869. *Gouldia declivis* Con., Am. Jour. Conch., vol. 5, p. 48, pl. 9, fig. 5.

1886. *Gouldia declivis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 126, pl. 18, fig. 11.

Description.—"Minute, triangular, compressed, equilateral, summit acute; posterior extremity angular, disk with numerous very regular, close concentric lines." (Conrad.)

Remarks.—The type specimen of this species seems to have been lost or destroyed, and no others have been met with in any of the more recent collections. The original specimen was only about 2 mm. or a little less in width. The description given above is Conrad's original definition of the species.

Formation and locality.—Woodbury clay, Haddonfield (183).

Geographic distribution.—New Jersey.

Eriphyla parilis (Conrad).

Plate LX., Fig. 11.

1853. *Astarte parilis* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 2, p. 276, pl. 24, fig. 16.

1861. *Astarte parilis* Gabb, Synop. Moll. Cret. Form., p. 156 (100).

1864. *Astarte parilis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 11.

1868. *Gouldia parilis* Con., Cook's Geol. N. J., p. 726.

1886. *Gouldia parilis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 126, pl. 18, figs. 12.

1905. *Eriphyla parilis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 14.

Description.—"Small, triangular, equilateral, compressed; basal margin regularly rounded; angles of the end margins situated at about equal distances from the apex and base; disk concentrically undulated." (Conrad.)

Remarks. The above is Conrad's original definition of the species. The type specimen in the collection of the Philadelphia Academy of Sciences is so badly injured that its true characters cannot be recognized. The specimen illustrated by Whitfield as a probable member of the species is only an impression of the

anterior portion of a *Trigonia* probably *T. eufaulensis*. No specimens have been found in the recent collections of the Survey which can be referred to the species.

Formation and locality.—Unknown, Monmouth County (Conrad).

Geographic distribution.—New Jersey.

Family CRASSATELLITIDAE.

Genus CRASSATELLITES Kruger.

Crassatellites subplanus (Conrad).

Plate LXI., Figs. 1–4.

1853. *Crassatella subplana* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 274, pl. 24, fig. 9.
1860. *Crassatella lintea* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 279, pl. 46, fig. 5.
1861. *Crassatella lintea* Gabb, Synop. Moll. Cret. Form., p. 168 (112).
1861. *Crassatella subplana* Gabb, Synop. Moll. Cret. Form., p. 169 (113).
1864. *Crassatella lintea* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 11.
1864. *Crassatella subplana* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 11.
1868. *Crassatella lintea* Con., Cook's Geol. N. J., p. 726.
1886. *Crassatella subplana* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 121, pl. 18, figs. 14-16.
1905. *Crassatellites lintews* Johns., Proc. Acad. Nat. Sci. Phil., (1905), p. 14.
1905. *Crassatellites subplanus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 14.

Description.—The dimensions of a small specimen, a nearly perfect right valve, are: length, 36 mm.; height, 28 mm.; convexity, 6 mm. Large individuals grow to a length of 50 mm. or more. Shell broadly subovate in outline, beak obtuse, situated about one-third the length of the shell from the anterior extremity.

Antero-cardinal margin straight or slightly concave, sloping downward from the beak; anterior margin rounding into the basal margin, moderately convex throughout to the postero-basal extremity, which is obtusely subangular; posterior margin short, truncated nearly vertically or slightly inclined; postero-cardinal margin gently convex, sloping downward from the beak and meeting the posterior margin in an obtuse angle. Surface of the shell with an obtusely angular umbonal ridge, which passes from the beak to the postero-basal angle in nearly a straight line, the post-cardinal slope slightly concave to the cardinal margin; the post-cardinal margin sharply inflected to form a rather deeply excavated escutcheon; antero-cardinal margin inflected to form a deep but rather ill-defined lunule. Surface of the shell marked by regular, somewhat imbricating, concentric lines of growth, and often by a few broader concentric undulations towards the margin. Hinge of the right valve with a strong cardinal tooth transversely striate on its anterior surface, directly beneath the beak. Behind it is a very large and broad triangular pit, with a much smaller secondary pit just behind the lower end of the tooth; in front of the cardinal tooth is a small triangular pit about equal in size to the secondary pit behind, and in front of this pit a low, obscure, tooth-like ridge extends obliquely forward to the upper margin of the anterior muscular scar. Muscular impressions strong and about equal in size. Inner margin of the free edge of the shell crenate.

Remarks.—The above description is based largely upon a very perfect right valve from the Marshalltown clay-marl near Swedesboro. The more usual method of preservation in the Navesink marl is in the form of internal casts. These casts have much the same general form as the shell described, but are proportionately lower, and the short, truncate posterior margin of the shell itself is not differentiated from the curving postero-cardinal margin; the beaks are rather large, directed forward, and elevated above the hinge-line; the muscular and pallial impressions are strongly defined. These common casts of the Navesink marl were apparently identified as *C. vadosa* by Whitfield, at least in part, but after a study of the types of that species as well as numerous other examples from the South, it has not seemed possible to identify

any of the New Jersey specimens with that species. *C. subplana* differs from *C. vadosa* in its much more depressed-convex valves, those of *C. vadosa* being quite ventricose, especially towards the umbo, although in their general outline and surface markings the two species are much alike.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177), Marshalltown (190); Wenonah sand, near Marlboro (130); Navesink marl, Alantic Highlands (108), near Walnford (148^2), Crosswicks Creek (147^4, 149, 195), near Jacobstown (150), Mullica Hill (169); Red Bank sand, near Red Bank (116); Tinton beds, Beers Hill cut, south of Keyport (129^5, 129^7, 129^9), near Freehold (132).

Geographic distribution.—New Jersey.

Crassatellites transversus (Gabb).

Plate LXI., Fig. 5.

1861. *Crassatella transversa* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 364.
1864. *Crassatella transversa* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 11.
1868. *Crassatella transversa* Con., Cook's Geol. N. J., p. 726.
1876. *Etea transversa* Con., Proc. Acad. Nat. Sci. Phil. (1876), p. 275.
1886. *Crassatella transversa* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 122, pl. 17, figs. 16-17.
1905. *Crassatellites transversus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 14.

Description.—The dimensions of an internal cast are: length, 49 mm.; height, 32 mm.; thickness, 20 mm. Shell very inequilateral, higher in front than behind, the beaks pointed in the internal casts and nearly erect, situated about one-third the length of the shell from the anterior extremity. Anterior margin convex in front, rounding to the hinge-line above and into the basal margin below; basal margin convex anteriorly and concave posteriorly; postero-basal margin sharply rounding into the obliquely subtruncate posterior margin, which rounds into the dorsal mar-

gin above. Valves with an umbonal ridge extending in a nearly straight line from the beak obliquely backward to the postero-basal extremity of the shell, becoming more angular posteriorly. The postero-cardinal slope rather narrow, flat, slightly concave or slightly convex. Surface of the shell marked with somewhat regular, rather strong, concentric lines of growth which are less conspicuous back of the umbonal ridge. In internal casts the muscular impressions are conspicuous and of about equal size. Free margin of the shell crenate.

Remarks.—In the recent collections of the Survey, this species has been observed only in the Wenonah sand near Marlboro where it occurs in the condition of modified casts of the interior and impressions of the outside of the shell, by reason of the compression of the imbedding material after the solution of the shell substance. The type specimen, which is the only individual previously recorded, is a clean cut internal cast with the muscular impressions strong, and without the markings of the external surface of the shell impressed upon it. The Marlboro specimens, however, agree so closely in their general form, size and proportions with the type specimen, that there can be little or no doubt as to their identity. Conrad's illustration of *C. ripleyanus*[1] has much the form of this *C. transversus,* and it is possible that the two forms may be identical.

Formation and locality.—Wenonah sand, near Marlboro (130[1]).

Geographic distribution.—New Jersey.

Crassatellites cuneatus (Gabb).

Plate LXI., Figs. 11–12.

1860. *Crassatella pteropsis* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 395, pl. 68, fig. 28. (Not *C. pteropsis* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 279, pl. 46, fig. 9.)

1861. *Crassatella cuneata* Gabb, Synop. Moll. Cret. Form., pp. 168, 169 (112, 113).

[1] Proc. Acad. Nat. Sci. Phil. (1872), pl. 1, fig. 7.

1864. *Crassatella cuneata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 11.

1886. *Crassatella cuneata* Whitf., Pal. N. J., vol. 1, (Monog. U. S. G. S., vol. 9), p. 118, pl. 17, figs. 18-20.

Description.—Shell small, the dimensions of a nearly complete internal cast are: length, 16 mm.; height, 10.5 mm.; thickness, 6.5 mm. Subovate in outline, cuneate behind. Beaks erect, rather prominent, situated about one-third the length of the shell from the anterior extremity. Antero-cardinal margin sloping forward from the beak; anterior margin rounding into the basal margin; basal margin convex in front and straight or slightly concave posteriorly; posterior margin short, truncate; post-cardinal margin long sloping backward from the beak and meeting the posterior margin at the extremity of the hinge-line in an obtuse angle. An obtusely subangular umbonal ridge passes in a nearly straight or slightly concave line from the beak to the postero-basal extremity; the postero-cardinal slope flat or slightly concave, the cardinal margin inflected. Surface of the shell marked with rather strong, regular, concentric lines of growth. In well preserved internal casts the post-cardinal margin and the truncate posterior margin are not sharply differentiated, the posterior extremity of the shell being rather sharply rounded. The muscular scars prominent in the casts. When the internal casts are well preserved to the margin of the shell, the free margins are finely crenate.

Remarks.—This is a small species and can usually be distinguished by its subcuneate posterior extremity. No specimens preserved in such a manner as to exhibit the hinge-characters have been observed, but there can be little or no question as to its proper generic position. The species occurs most commonly in the Merchantville clay-marl, and Whitfield's specimens from Monmouth, probably meant for Monmouth County, doubtless came from that horizon.

Formation and locality.—Merchantville clay-marl, near Matawan (101), near Jamesburg (141), Lenola (163); Wenonah sand, near Crawfords Corner (126^3).

Geographic distribution.—New Jersey.

Crassatellites prorus (Conrad).

Plate LXI., Figs. 6–7.

1869. *Crassatella prora* Con., Am. Jour. Conch., vol. 5, p. 43, pl. 1, fig. 8.
1876. *Etea prora* Con., Proc. Acad. Nat. Sci. Phil. (1876), p. 275.
1886. *Crassatella prora* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 120, pl. 17, figs. 10-11.
1905. *Crassatellites prorus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 14.

Description.—"Shell below a medium size, transversely subelliptical when considered exclusive of the projection of the beaks, but transversely broad triangular if they are considered. Valves rather ventricose for the genus; beaks very large, nearly central or a little nearest the anterior end, strongly projecting, and in the cast, the only condition in which it is known, nearly erect and moderately distant. Posterior cardinal margin regularly sloping from the beaks to the narrowly rounded posterior extremity; anterior side of the beaks excavated and the anterior end more broadly rounded than the opposite end; basal line broadly curved. Umbonal ridge scarcely angular. Surface, as shown on the casts, marked by comparatively strong, regular, concentric ridges, and marked just anterior to the umbonal angle by a proportionally broad sulcation passing from near the beaks to the base. Muscular scars distinct." (Whitfield.)

The dimensions of the type specimen are: length, 22.5 mm.; height, 15 mm.; thickness, 10 mm.

Remarks.—This species has been only rarely met with in the recent collections of the Survey. It is of a rather exceptional form for species of this genus, in its subelliptical outline and its nearly central beaks. It is quite different in all its characters so far as they are preserved, from typical members of the genus *Etea* where Conrad has referred it, although the hinge characters have not been observed. It seems better, therefore, to allow it to remain in the genus where it was originally placed, than to transfer it to another.

Formation and locality.—Merchantville clay, near Matawan (101). Crosswicks (Conrad).

Geographic distribution.—New Jersey.

Crassatellites littoralis (Conrad).

Plate LXI., Figs. 9–10.

1869. *Crassatella littoralis* Con., Am. Jour. Conch., vol. 5, p. 41, pl. 1, fig. 3.

1886. *Crassatella conradi* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 209, pl. 28, figs. 1-5.

1886. *Crassatella littoralis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 212, pl. 28, figs. 6-7.

Description.—The dimensions of an incomplete right valve, upon which the shell is partially preserved, are: length, 35 mm.; height, 29 mm.; convexity, 8 mm. Shell subovate in outline, with moderately convex valves; beaks situated at about the anterior third of the shell. Antero-cardinal margin sloping steeply downward from the beak, the anterior margin rounding regularly into the basal margin; basal margin regularly convex; postero-basal extremity rather abruptly rounding; posterior margin gently convex, nearly vertically or a little obliquely subtruncate; post-cardinal margin sloping backward to the posterior hinge extremity; greatest height of the shell opposite the beaks. A more or less obscure, rather broadly rounded umbonal ridge passes from the beak to the postero-basal angle. Surface of the shell marked with somewhat regular and rather strong concentric lines of growth, which seem to be most strongly marked anteriorly. Shell substance rather thick, and when the outer surface is exfoliated a series of more or less conspicuous radiating markings can be seen. Inner surface of the free margin of the shell crenate. In the internal casts, the usual condition of the species, the beaks are prominent, highly elevated, and rather distant, the muscular and pallial impressions are of moderate strength; the umbonal ridge is variable, being subangular or broadly rounded in some individuals, and in others scarcely differentiated at all in the casts.

Remarks.—Whitfield has recognized two distinct species of *Crassatellites* from the Manasquan marl, of about the same size and very similar in form. Internal casts belonging to one or the other of these species are not uncommon in the fauna of this bed near Farmingdale and elsewhere, but it is practically impossible to identify the two forms with any certainty. The most essential difference between the two forms, judging from a careful study of the descriptions and illustrations, together with at least a portion of the typical specimens used by Whitfield, is to be found in the character of the surface markings of the shells, *C. littoralis* having rather strong, regular, approximate, concentric lines of growth, while *C. conradi* has rather fine radiating costæ. A careful study of the specimens, however, seems to show without doubt that these differences are only differences in the preservation of the shells, specimens having the actual surface intact being marked with the concentric lines of growth, while those specimens upon which the shell surface is exfoliated, exhibit the radiating costæ. Whitfield's illustration of *C. littoralis* showing the shell surface (fig. 6), is a great deal restored, and on the specimen itself, certain portions of which have been more or less deeply exfoliated, the radiating costæ are clearly vizible at several points. On the other hand, one of the type specimens of *C. conradi* (figs. 4-5), preserves a portion of the shell on the side opposite to that which is illustrated, upon which fine radiating costæ are clearly seen, but upon careful examination it can be seen that the actual shell surface has been nearly all removed and at those points where it still remains it is concentrically marked; a portion of the shell of this same specimen is also shown in the illustration marked with concentric lines of growth, although in its present condition the specimen has lost this portion of the shell. From this it will be seen that the surface ornamentation of the shells does not constitute a legitimate means of distinguishing the two species. The differences in the outlines of the casts also seem to be nonessential. Practically all specimens are more or less imperfect about the margin, so that they appear to be of various forms, and the angularity and prominence of the umbonal ridge seems to be a variable character that cannot be depended upon for specific value. From all these considerations, therefore,

it seems impracticable to recognize two distinct species of these shells, and they have all been thrown together in one species, *C. littoralis*. Conrad originally described this species as coming from the Eocene beds at Shark River, but this was doubtless an error, and was one which might easily have been committed considering the close stratigraphic and lithologic relations of the Shark River and Manasquan formations. There is no known Shark River shell which could be easily mistaken for the shell under discussion, while the common casts and occasional shells in the Manasquan agree quite closely with the form which Conrad described. Another species which should be considered in this place is *C. rhombea* Whitf., which occurs in the same fauna, but which is considerably larger than the typical form of *C. littoralis;* the casts of this species, except in their larger size, are not very essentially different from the smaller ones, neither are the surface markings of the shell inconsistent with *C. littoralis*. It therefore seems quite possible, indeed not improbable, that *C. rhombea* may also be considered as a synonym of *C. littoralis*, this name having been applied merely to the exceptionally large individuals. For the present, however, this species will be considered as distinct.

Formation and locality.—Manasquan marl, near Farmingdale (138), near New Egypt (155), Shark River, Squankum (Whitfield).

Geographic distribution.—New Jersey.

Crassatellites rhombea (Whitfield).

Plate LXI., Fig. 8.

1886. *Crassatella rhombea* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 213, pl. 27, figs. 16-19.

Description.—The dimensions of a large internal cast are: length, 52 mm.; height, 43.5 mm.; thickness, 29 mm. Shell subrhomboidal in outline or, exclusive of the projection of the beaks, subovate, widest posteriorly; beaks large, prominent and rather distant, considerably produced above the hinge-line, situ-

ated at about the anterior third of the shell's length. Antero-cardinal margin sloping steeply forward from the beaks; anterior margin rounded from the lower extremity of the lunule into the regularly convex ventral margin; postero-basal extremity rounding somewhat abruptly into the gently convex, obliquely subtruncate posterior margin; postero-cardinal margin sloping backward from the beak to the posterior extremity of the hinge-line. Free margin of the shell crenate internally. Valves prominently rounded along an oblique line from the beak to the postero-basal extremity, but without a distinct umbonal ridge. Surface of the shell marked by more or less irregular concentric lines of growth, and by more or less indistinct radiating costæ, which are finer in front becoming regularly larger posteriorly, the larger ones being a little over one millimeter in width.

Remarks.—This species is the largest member of the genus recognized in the fauna of the Manasquan marl, and occurs most commonly in the form of internal casts. In these casts the beaks are more erect than in specimens with the shell preserved and they seem to be a little nearer the center of the shell. The muscular impressions are large and prominent and are connected by the well-defined pallial impression.

Formation and locality.—Manasquan marl, New Egypt and Squankum (Whitfield).

Geographic distribution.—New Jersey.

Genus SCAMBULA Conrad.

Scambula perplana Conrad.

Plate LXI., Figs. 13–14.

1869. *Scambula perplana* Con., Am. Jour. Conch., vol. 5, p. 48, pl. 9, figs. 7-8.

1872. *Scabula perplana* Con., Proc. Acad. Nat. Sci. Phil. (1872), p. 51, pl. 1, fig. 2.

1886. *Scambula perplana* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 123, pl. 18, figs. 8-10.

1905. *Crassatellites* (*Scambula*) *perplanus* Johns., Proc. Acad. Nat. Sci Phil. (1905), p. 14.

Description.—"Shell small, triangularly ovate, very transverse, with very sharp, pointed, and recurved beaks, situated just within the middle third of the length of the shell and nearest to the anterior end. Valves flat, marked by fine concentric lines of growth and a few (three or four) broad, oblique undulations of the surface which pass from the posterior hinge-line forward to the basal margin. There are also a few obliquely concentric wrinkles on the antero-cardinal margin which extend only a short distance over the disk of the valve. Along the position of the posterior umbonal ridge, the surface striæ are abruptly deflected upward, marking the position of the ridge and defining the posterior slope of the valve. Posterior end of the valve narrow and truncate; anterior end obtusely angular; basal margin regularly and broadly arcuate. Inner margin of the valves crenulate; muscular scars small and faintly marked." (Whitfield.)

Remarks.—This species has previously been known from but a single locality, Haddonfield, New Jersey. It is now recognized in two other localities, at Lorillard in the Woodbury clay, the same horizon as the Haddonfield specimens, and at a locality near Marlboro in the Wenonah sand. The Lorillard specimens are, for the most part, fragmentary, but they are usually larger than those from Haddonfield, one specimen having a length of 25 mm., and the broad, oblique undulations are more conspicuous. The Marlboro specimens do not grow larger than those from Haddonfield and seem to lack entirely the oblique undulations.

Formation and locality.—Woodbury clay, Haddonfield (183), and Lorillard (102); Wenonah sand, near Marlboro (130).

Geographic distribution.—New Jersey.

Super-family CYRENACEA.

Family CYRENIDAE.

Genus CORBICULA Megerle.

Corbicula annosa (Conrad).

Plate LXII., Figs. 1–3.

1869. *Astarte annosa* Con., Am. Jour. Conch., vol. 4, p. 279, pl. 20, fig. 5.

1870. *Astarte annosa* Con., Am. Jour. Conch., vol. 5, p. 227.
1886. *Corbicula annosa* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 26, pl. 2, figs. 2-4.

Description.—"Suborbicular, convex, very inequilateral, ventral and anterior margins regularly and nearly equally rounded; posterior end truncated, direct (cast.)." (Conrad).

"I have before me two specimens which I have referred to this species. They are both somewhat distorted by compression and retain but little of the substance of the original shell, other than the epidermis, which has been very strong, and a ferruginous replacement of the ligament. The specimens are both very ventricose, with a somewhat subquadrangular outline and a moderately angular umbonal ridge. The beaks are small and nearly anterior, hinge line short and oblique, with a small ligament. Anterior end short and rounded, while the posterior is broadly truncated, corresponding to the rather broad and abrupt postero-cadinal slope. If I have rightly identified the species, there can be no reason for referring it to *Artarte* in the light afforded by the two specimens, but every appearance would indicate their relations to the genus *Corbicula,* with which I have placed it." (Whitfield.)

Formation and locality.—Raritan clay, Sayreville and Woodbridge (Whitfield).

Geographic distribution.—New Jersey.

Corbicula ? emacerata Whitfield.

Plate LXII., Figs. 4–5.

1886. *Corbicula ? emacerata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 26, pl. 2, figs. 5-6.

Description.—"Shell of rather small size, transversely elliptical or subovate in outline, and moderately ventricose. Beaks moderately large but not prominently so, and situated at about the anterior fourth of the length of the shell. Anterior end of the shell the highest, the anterior margin narrowly rounded; basal line strongly curved and the posterior end narrow and

obliquely truncate, the cardinal portion rapidly sloping with a slight curvature to the extremity of the moderately sized ligament; hinge line short and oblique to the axis of the shell. Umbonal angle distinct but not marked, and the cardinal slope narrow and rather abrupt. Surface marked only by fine concentric striæ, which appear to have been confined principally to the epidermal layer." (Whitfield.)

Formation and locality.—Raritan clay, near Woodbridge.

Geographic distribution.—New Jersey.

Super-family CARDITACEA.

Family CARDITIDAE.

Genus CARDITA Bruguière.

Cardita intermedia Whitfield.

Plate LXII., Figs. 6–8.

1886. *Cardita intermedia* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 209, pl. 28, figs. 14-15.

Description.—The dimensions of the type specimen are: length, 20 mm.; height, 17 mm.; thickness, 12.5 mm. Shell subovate in outline exclusive of the beaks, broadest posteriorly. The beaks large and prominent in the casts, considerably elevated above the hinge-line, situated in front of the middle, inclined forward. Hinge-line arcuate; anterior margin narrowly rounded; basal margin strongly convex; posterior margin broadly rounded. Valves ventricose; the muscular scars rather small but distinct. Shell marked by 10 or 12 rather strong radiating ribs whose presence is shown in the casts only along the ventral border between the two muscular scars.

Remarks.—This species has not been certainly met with in the recent collections, the above description being based upon Whitfield's figure and description and the type specimen which is preserved in the collection of Columbia University.

Formation and locality.—? Vincentown sand, near Deal (122); Manasquan marl, Farmingdale (Whitfield.)

Geographic distribution.—New Jersey.

Genus VETERICARDIA Conrad.

Vetericardia crenalirata (Conrad).

Plate LXII., Figs. 9–10.

1860. *Astarte crenalirata* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 282, pl. 46, fig. 25.
1861. *Astarte crenulirata* Gabb, Synop. Moll. Cret. Form., p. 156 (100).
1864. *Astarte crenulata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 11.
1867. *Astarte corbicula* Con., Am. Jour. Conch. ? vol. 3, p. 12.
1868. *Gouldia ? crenulirata* Con., Cook's Geol. N. J., p. 726.
1869. *Vetocardia crenalirata* Con., Am. Jour. Conch., vol. 5, p. 43, pl. 1, fig. 23.
1872. *Vetericardia crenalirata* Con., Proc. Acad. Nat. Sci. Phil. (1872), p. 52, pl. 1, fig. 4.
1886. *Vetericardia crenulirata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 128, pl. 18, figs. 5-7.

Description.—"Shell small, not exceeding one-fourth of an inch in length in adult individuals, subtriangular or broadly subelliptical in outline, with very ventricose valves and proportionally large, suberect beaks, which are situated a little in advance of the middle. Surface marked by from 13 to 18 concentric varices, according to the size of the shell, which gradually increase in strength with increased growth of the shell. These become obsolete at the margin of the proportionally large and deeply impressed lunule. Interspaces flattened at the bottom, and about as wide as the sharply elevated varices. There are also fine, but distinct elevated radiating lines crossing the ridges and interspaces, becoming much stronger on the spaces than on the ridges. In the interior the muscular imprints are faintly marked and of moderate size, and the margin of the valves is strongly and deeply crenulated by the radiating ridges. Hinge-plate moderately strong and the teeth well marked." (Whitfield.)

Remarks.—This species has previously been recorded only from the Woodbury clay, but in the recent collections of the Survey a single incomplete impression of a specimen has been detected in the Merchantville clay-marl.

Formation and locality.—Merchantville clay-marl, Lenola (163); Woodbury clay, Haddonfield (183).

Geographic distribution.—New Jersey, Mississippi.

Super-family CHAMACEA.

Family DICERATIDAE.

Genus DICERAS Lamark.

Diceras dactyloides Whitfield.

Plate LXII., Figs. 11–12.

1886. *Diceras dactyloides* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 131, pl. 18, figs. 26-27.

Description.—"A cast of a single valve of what appears to be without question a *Diceras* occurs in the collection. It is rather slender in its proportions, and makes nearly two-thirds of a volution in its curvature, and is apparently a cast of a left valve, judging from the curvature of the beak. The muscular scar is very large, and has been deeply impressed in the shell, as the scar is considerably raised on the cast and is nearly half as long as the cast itself. On its front margin there is the filling of a deep groove, which is longitudinally marked with lamellose striæ, from the edges of the shell lamellæ; and on the opposite side of the cast occurs a flattened surface from the thickening of the shell below the hinge-tooth, probably.

The striations on the filling of the groove bordering the muscular imprint would lead one to suspect the cast might be of a valve of *Caprina,* but their lamellose character somewhat denies this reference, and the general character of the specimen would rather indicate a *Diceras.* The specimen is quite obscure, besides being the only one known, and consequently affords almost no means of comparison with previously described species. It, how-

ever, appears much more slender in its proportions than the species known from Texas and other southern localities, as well as more strongly enrolled." (Whitfield.)

Remarks.—The type specimen of this species is the only example which has been observed, the species not having been met with in the recent collections of the Survey.

Formation and locality.—Navesink marl, Bruere's marl pit, near Walnford (Whitfield).

Geographic distribution.—New Jersey.

Family CAPRINIDAE

Genus CAPROTINA d'Orbigny.

Caprotina jerseyensis n. sp.

Plate LXII., Figs. 13–15.

Description.—The type specimen with a maximum length of 21.5 mm., a width of 13 mm., and a depth of 15 mm. Beaks curving to the left. Lower valve much deeper than the upper, attached by nearly one-half its entire surface, the beak projecting far beyond that of the upper valve. Upper valve moderately convex. The shell substance is preserved only on a portion of the upper valve where the surface markings are seen to be very narrow but rather highly elevated, sharp, radiating costæ, the interspaces being twice as wide as the ribs; the radiating markings are crossed by very fine concentric lines of growth. On the internal cast both the radiating and concentric markings are faintly impressed.

Remarks.—This species is founded upon a single individual preserving both valves. It is for the most part a cast of the interior of the shell, but a portion of the shell itself is preserved upon the upper valve, and sufficient fragments of the shell are still preserved upon the lower valve to show that the surface markings were essentially the same on both. The specimen is nearly complete, the beak only of the lower valve being injured. The species should be compared with *Caprotina cenomanensis* d'Orbigny,[1] from the Upper Cretaceous of France.

[1] Pal. Franc., Terr. Cret., vol. 4, p. 261, pl. 595, figs. 1-4.

Formation and locality.—Navesink marl, near Crawfords Corner (126[7]).

Geographic distribution.—New Jersey.

Super-family LUCINACEA.

Family UNICARDIIDAE.

Genus UNICARDIUM d'Orbigny.

Unicardium umbonata (Whitfield).

Plate LXII., Figs. 16–17.

1886. *Sphæriola umbonata* Whit., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 152, pl. 19, figs. 17-18.

1905. *Sphæriola umbonata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 14.

Description.—The dimensions of a large left valve are: length, 57 mm.; height, 54 mm.; convexity, 18.5 mm. Shell very thin, subcircular or slightly subquadrangular in outline. Cardinal margin arcuate, edentulus; anterior margin broadly rounded, its most anterior point being at or below the middle, rounding below into the basal margin; basal margin curving upward at each end, straighter in the middle; posterior margin usually a little shorter than the anterior, regularly rounded or some times a little straightened in the middle. Beaks strongly incurved, pointing forward, situated at the middle or a little back of the middle of the cardinal margin; umbones prominent, much elevated above the hinge-line. Valves strongly convex or ventricose, the anterior slope somewhat more abrupt than the posterior, slightly compressed towards the cardinal extremities. Surface of the shell marked only by concentric lines of growth which are more or less irregular in the strength of their development.

Remarks.—This species was described by Whitfield from a very imperfect cast of the interior, and was referred to the genus *Sphaeriola* without any knowledge of the hinge characters. In the recent collections of the Survey specimens preserving the shell have been secured from the Marshalltown clay-marl near

Swedesboro, and from these it has been learned that the hinge is edentulous, a character which prohibits its reference to the genus *Sphaeriola*. The hinge characters, as well as the general form and characters of the shell, seem to agree in all essential respects with members of the genus *Unicardium*, and the species is therefore transferred to that genus.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177); Navesink marl, Atlantic Highlands (108^2), near New Egypt (147^4).

Geographic distribution.—New Jersey.

Family LUCINIDAE.

Genus LUCINA Bruguière.

Lucina cretacea Whitfield.

Plate LXII., Fig. 18.

1869. Conrad, Am. Jour. Conch., vol. 5, pl. 9, fig. 14.
1886. *Lucina cretacea* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 129, pl. 18, figs. 23-25.

Description.—"Shell rather below a medium size, subcircular in outline, with the anterior and posterior margins forming a very broad angle (140° to 160°) with each other; giving in some instances a nearly straight hinge-line, with the rather small, pointed beaks slightly projecting beyond the line, and a slight excavation in front, formed by the depression of the very narrow lunule; while behind the beaks the ligament is deeply sunken between the projecting shell margins. Surface of the shell marked by strong lamellose concentric lines, which are rather distant, and where there has been no wearing or abrasion they sometimes roll backward, and form a hollow rounded concentric ridge. On the posterior side the shell is marked by a rather deep constriction passing from the beak to the posterior margin just behind the umbonal ridge, or sometimes giving a sunken postero-cardinal area. In the interior the muscular markings are very deep and strong, and the hinge-plate narrow, the right

valve being characterized by a single cardinal tooth, which is grooved on the surface, and by an anterior pit." (Whitfield.)

Remarks.—An illustration of this species was published by Conrad as indicated above, but without name or description. Whitfield found specimens in the collections of the Philadelphia Academy of Science labeled *"Cyclas cretacea"* in Conrad's handwriting, and adopted Conrad's specific name, but Whitfield himself is the real author of the species.

The species attains a much greater size at times, than is indicated by Whitfield's illustration, the larger one of the specimens figured by that author having a length of 16 mm. and a height of 15 mm. The larger specimens from Lorillard are frequently over 20 mm. in length.

Formation and locality.—Cliffwood clay, Cliffwood Point (105), near Matawan (186); Woodbury clay, near Haddonfield (164, 165, 183), Crosswicks (168), near Matawan (101), Lorillard (102); Red Bank sand, Shrewsbury River (116), near Middletown (112).

Geographic distribution.—New Jersey, Alabama.

Lucina swedesboroensis n. sp.

Plate LXII., Figs. 19–21.

Description.—The dimensions of a small but nearly perfect individual are: height, 13.5 mm.; length, 14 mm.; thickness, 6 mm. The dimensions of another left valve are: height, 14.5 mm.; length, 16 mm. The larger individuals sometimes attain a height of 20 mm. Shell subcircular, varying from a little higher than long to slightly longer than high. Beaks small, pointing forward. Valves depressed convex with a very obscure arcuate umbonal prominence extending from the beak obliquely to the postero-basal margin; post-cardinal margin sharply inflected to form a narrow and deep escutcheon; in front of the beaks the margin is sharply inflected to form a small but profound lunule. Surface of the shell marked by rather fine, more or less irregular concentric lines of growth. Hinge-line arcuate; hinge of the left valve with a large, triangular cardinal tooth beneath

the beak, and another obscure one directed obliquely backward, in front of the beaks is a single lateral tooth beneath the lunule and close to the shell margin, back of the beak and remote from it, extending nearly to the posterior extremity of the hinge-line, is a low, elongate, posterior cardinal tooth.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177).

Geographic distribution.—New Jersey, Mississippi.

Family DIPLODONTIDAE.

Genus TENEA Conrad.

Tenea parilis Conrad.

Plate LXIII., Figs. 1–6.

1860. *Mysia (Diplodonta) parilis* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 278, pl. 46, fig. 16.

1870. *Tenea parilis* Con., Am. Jour. Conch., vol. 6, p. 73, pl. 3, fig. 12.

1875. *Tenea parilis* Con., Kerr's Geol. N. Car., App. p. 8, pl. 2, fig. 25.

1884. *Tenea parilis* Tryon, Syst. and Struct. Conch., vol. 3, p. 216, pl. 119, fig. 72.

1886. *Dosinia Gabbi* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 161, pl. 22, figs. 4-5.

1886. *Tenea pinguis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 163, pl. 22, figs. 1-2, not fig. 3 (not *T. pinguis* Con.).

1905. *Tenea parilis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 15.

Description.—Shell in large examples attaining a length and height of 38 mm.; the depth of each valve being 13 mm. The valves more or less strongly and evenly convex, subcircular, obscurely subquadrangular or subovate in outline, beaks prominent, directed forward, slightly incurved. The post-cardinal margin deeply inflected. Each valve furnished with two cardinal teeth

and no laterals. Muscular impressions rather large but not deeply impressed, pallial line with a deep, narrow, acutely subangular sinus, whose inner extremity is directed towards a point between the beak and the anterior muscular impression. Surface of the shell nearly smooth, marked only by fine lines of growth.

Remarks.—The type specimens of *Lucina pinguis* Con. and *Mysia gibbosa* Gabb, are certainly members of the same species, but that of *Mysia parilis* Con., seems to be a distinct form, although it has frequently been considered as a synonym of the others. Both species are here referred to the genus *Tenea*. *T. pinguis* has not been observed to grow as large as *T. parilis;* it is much more gibbous, the entire shell being almost globular in form, and it seems to have been marked with stronger concentric lines of growth. The only authentic examples of the species seem to have come from the Navesink marl, while *T. parilis* occurs in the lower formations, although it has also been observed in the Red Bank sand. Whitfield's type of *Dosinia gabbi* is a good typical example of the form here considered as *T. parilis,* and one of the specimens he has illustrated as *T. pinguis* is also a typical representative of this species, although somewhat more ovate than usual. The hinge characters have not been observed in any of the examples in the recent collections of the Survey, but the specimen upon which the genus *Tenea* was established came from the Woodbury clay near Haddonfield where the fauna is essentially like that at Lorillard. The specimens of *T. parilis* from Lorillard are much larger than the type of the species, but there are specimens of the species in the National Museum from the typical locality in Tippah County, Mississippi, which are much larger than the type. Considerable individual variation is exhibited among different examples of the species, the more usual form is subcircular or obscurely subquadrangular, but occasionally one is met with which is more nearly subovate in outline. Many of the southern examples of the species retain the shell itself, which is very thin and marked only by fine, concentric lines of growth.

Formation and locality.—Cliffwood clay, Cliffwood Point, (105); Merchantville clay-marl, near Jamesburg (141), Lenola

(163); Woodbury clay, Lorillard (102), near Matawan (103), near Haddonfield (164, 165, 183); Wenonah sand, near Crawfords Corner (126[3]), near Marlboro (130[1]); Navesink marl, Crosswicks Creek (147[3], 195); Red Bank Sand, Shrewsbury River (119), Red Bank (116); Tinton beds, Beers Hill cut, south of Keyport (129[5]).

Geographic distribution.—New Jersey, North Carolina, Mississippi, Texas, Arkansas.

Tenea pinguis Conrad.

Plate LXIII., Fig. 7.

1853. *Lucina pinguis* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 2, p. 275, pl. 24, fig. 18.
1860. *Mysia gibbosa* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser. vol. 4, p. 302, pl. 48, fig. 17 (not 18).
1861. *Lucina pinguis* Gabb, Synop. Moll. Cret. Form., p. 195 (138).
1864. *Lucina pinguis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 12.
1868. *Lucina ? pinguis* Con., Cook's Geol. N. J., p. 726.
1876. *Tenea pinguis* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 307.
1886. *Tenea pinguis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 163, pl. 22, fig. 3 (not figs. 1-2 = *Tenea parilis*).
1905. *Tenea pinguis* John., Proc. Acad. Nat. Sci. Phil. (1905), p. 15.

Description.—Shell small, the dimensions of one specimen being: height, 7 mm.; width, 8 mm.; thickness, 6 mm.; subcircular or obscurely subquadrangular in outline. Valves extremely ventricose or gibbous, giving to the entire shell a nearly globular form. Umbones very prominent, the beaks incurved and directed forward. Surface of the shell marked by somewhat prominent concentric lines of growth.

Remarks.—The relations of this species to *T. parilis* have been fully considered in connection with the discussion of that species. It apparently differs from *T. parilis* chiefly in its smaller size, its greater gibbosity and its stronger concentric lines of growth.

Formation and locality.—Navesink marl, near Walnford (148[2]).

Geographic distribution.—New Jersey.

Super-family CARDIACEA.

Family CARDIIDAE.

Genus CARDIUM Linneus.

Cardium nucleolus (Whitfield).

Plate LXIII., Figs. 8–9.

1886. *Criocardium nucleolus* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 214, pl. 28, figs. 10-11.

Description.—The dimensions of the type specimen are: height, 10 mm.; width, 10 mm.; thickness, 7.5 mm. Shell obscurely quadrangular in outline. Hinge-line arcuate; anterior and basal margins forming a single regular curve; postero-basal extremity sharply rounded; posterior margin obliquely truncate. Beaks nearly central, erect, moderately incurved and closely approximate. Valves ventricose with a subangular umbonal ridge from the beak to the postero-basal margin; posterior slope narrow and abrupt; in front of the umbonal ridge the surface is regularly curved to the anterior margin. Muscular impressions distinct and rather large on the casts; inner free margins of the valves crenate. Surface characters and hinge unknown.

Remarks.—This is a peculiar, small, rotund form which is the only representative of the genus yet observed from the Manasquan marl. Whitfield referred the species to the subgenus *Criocardium,* but in the absence of any knowledge of the surface features of the shell this reference can only be considered as tentative. It seems to be a rare form as it has not been met with in the recent collections of the Survey.

Formation and locality.—Manasquan marl, Farmingdale (Whitfield).

Geographic distribution.—New Jersey.

Cardium wenonah n. sp.

Plate LXIII., Figs. 10–16.

Description.—The dimensions of an average right valve are: height, 12 mm.; width, 12 mm.; convexity, 4 mm. Large individuals rarely attain a height of nearly 20 mm. Shell, exclusive of the projecting beaks, subrhomboidal in outline. Hinge-line nearly straight; anterior margin rounded, most convex above the middle, curving rather abruptly below into the gently convex basal margin which is subparallel with the hinge-margin; postero-basal margin abruptly rounded; posterior margin gently convex, slightly oblique, straighter than the anterior margin. Beaks small, pointed, incurved, situated at about the middle of the hinge-line and but little elevated above it. Along a line extending from the beak obliquely backward to the postero-basal extremity, is a rounded umbonal prominence, but the most prominent portion of the valve is usually in front of this line near the center of the shell; the posterior slope from the umbonal prominence is rather abrupt, nearly flat or slightly concave, the valves becoming somewhat compressed towards the cardinal extremity; in front the surface curves gently upward to the center of the valve, then downward, becoming a little more abrupt as it approaches the anterior margin. Muscular impressions inconspicuous. Lateral teeth of the hinge strong, nearly horizontal in position, the anterior one sloping downward a little more than the posterior; cardinal teeth not clear in the specimens. Free margins of the valves crenate. Surface of the shell marked by about 30 squarish, flat-topped, radiating costæ, about as wide or a little wider than the interspaces. In the condition in which the type specimens are preserved, these costæ are impressed upon the surface of the casts from the margins to the beaks, but are rounder on top than on the outside of the shell.

Remarks.—At its typical locality in the top of the Wenonah sand near Marlboro, this species occurs in great abundance. The

shells themselves have been removed by solution and the soft material in which they were buried, has been compressed so it is possible that the radiating costæ of the outside of the shell have been impressed more strongly upon the surface of the casts than they would be under other conditions. A large proportion of the specimens in this locality have been more or less distorted, but there is little difficulty in recognizing the species by reason of its small size and its smooth costæ which are always about 30 in number. In the undistorted specimens the subrhomboidal outline is always quite noticeable.

This species occurs abundantly at Corsicana, Texas, with the shell itself perfectly preserved. In the central portion of the inside of the shell in the Texas examples, there are radial rows of rather large pits occupying the position of the interspaces between the ribs on the outside. These pits pierce the inner layers of the shell only, but when the outside is slightly exfoliated they appear as perforations through the shell. The surface is marked by concentric, sublamellose lines of growth which are frequently eroded. The species should be compared with *C. choctawensis* Shum.,[1] but that species possesses much more conspicuous concentric markings which give to the ribs a crenulated appearance.

Formation and locality.—Wenonah sand, near Marlboro (130); ? Red Bank sand, near Middletown (112).

Geographic distribution.—New Jersey, Texas.

Cardium eufaulensis Conrad.

Plate LXIII., Figs. 17–20.

1860. *Cardium Eufaulensis* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 282, pl. 46, fig. 12.

1861. *Cardium Eufalensis* Gabb, Synop. Moll. Cret. Form., p. 162 (106).

1864. *Cardium eufalense* Meek, Check List. Inv. Foss. N. A., Cret. and Jur., p. 12.

1868. *Cardium* (*Trachycardium*) *Eufalense* Con., Cook's Geol. N. J., p. 726.

[1] Trans. St. Louis Acad. Sci., vol. 1, p. 599; also White's Cont. to Pal., No. 2, pl. 18, figs. 7 a-c.

1876. *Cardium* (*Trachycardium*) *Eufalense* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 310.

Not 1886. *Cardium Eufaulensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 132, pl. 20, figs. 17-19.

Description.—The dimensions of the internal cast of a left valve are: height, 26.5 mm.; width, 21.5 mm.; convexity, 9 mm. Shell obliquely ovate in outline. Hinge-line arcuate; anterior and basal margins rounding regularly with slightly decreasing curvature from the anterior cardinal extremity to the postero-basal extremity; postero-basal margin rounded; posterior margin gently convex or nearly straight, always straighter than the anterior margin. Beaks small, acute, incurved, only a little elevated above the hinge-line. Valves strongly convex, with a rounded umbonal prominence passing obliquely backward from the beak to the postero-basal extremity; posterior slope short, abrupt, nearly flat or sometimes slightly concave; anterior slope much longer, convex, becoming a little more abrupt anteriorly. Muscular impressions inconspicuous on the casts, the inner free margins of the valves crenate, surface of the casts sometimes smooth, sometimes showing impressions of the radiating ribs half way to the beak from the margin. Outer surface of the valves marked by from 35 to 40 angular, radiating costæ, where the shell is exfoliated these ribs appear to be hollow or tubular and their position is indicated by depressed furrows instead of elevations.

Remarks.—The specimens which were referred to this species by Whitfield really belong to two different species, neither one of them being the true *C. eufaulensis*. The specimens which have been identified as *C. eufaulensis* in the present report, agree closely with Conrad's original description and illustration, and agree with authentic specimens from the South. They have been recognized only in the Wenonah sand, where they are associated with *C. longstreeti,* but differ from that species in being more elongate and relatively narrower, and more regularly oval in outline without the subangular postero-basal extremity. The radiating ribs of the two species are also very different, those of *C. eufaulensis*

being broader, less abruptly elevated from the interspaces, and lacking the small nodes upon their summits. The specimens observed vary somewhat in outline, some individuals being relatively lower and broader than the one whose dimensions are given.

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey, North Carolina, Alabama, Mississippi, Arkansas.

Cardium longstreeti n. sp.

Plate LXIII., Figs. 21–22.

Description.—The dimensions of the internal cast of a left valve are: height, 33 mm.; width, 31 mm.; convexity, 10 mm. Shell obliquely subovate in outline. Hinge-line arcuate; antero-cardinal margin nearly straight, sloping downward from the beak to the anterior hinge extremity, curving below without break into the anterior margin; anterior and basal margins rounding with a regular, slightly decreasing curvature from the anterior hinge-extremity to the postero-basal extremity; postero-basal extremity subangular, situated considerably above the base of the shell; posterior margin obliquely truncate, rounding above to the posterior hinge-extremity. Beaks small, acute, incurved, moderately elevated above the hinge-line, pointing slightly backward at their tips. Valves with an umbonal prominence passing obliquely from the beak to the postero-basal extremity, in the casts it is subangular, but in the shell itself more rounded; the most prominent portion of the shell lies in front of this umbonal ridge; posterior slope narrow, somewhat flattened or concave; anterior slope gently convex across the middle of the shell, becoming more abrupt towards the anterior margin. The inner free margins of the shell strongly crenate, and the radiating ribs present upon the internal casts half way or more to the beaks. Muscular impressions inconspicuous upon the casts. Surface of the shell marked by about 38 rather high, angular ribs with small, more or less distant nodes along their summits; these

ribs grow regularly larger in passing from the anterior cardinal extremity to the postero-basal angle, those upon the posterior slope are notably thinner and more sharply angular than those upon the central and anterior portion of the shell, and one, about the second or third from the postero-cardinal extremity, is much higher and more conspicuous than the others.

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey.

Cardium whitfieldi n. sp.

Plate LXIV., Fig. 8.

1886. *Cardium eufaulensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 132, pl. 20, fig. 17 (not figs. 18-19). (Not *C. eufaulensis* Conrad.)

Description.—The dimensions of an internal cast are: height, 58 mm.; width, 55 mm.; thickness, 38 mm. Shell subcircular in outline; hinge-line nearly straight; anterior and basal margins curving with a regular, slightly decreasing curvature from the anterior hinge extremity to the postero-basal region; postero-basal extremity a little more sharply rounded; posterior margin convex, a little straighter than the anterior. Beaks, in the cast, rather small, nearly erect, acute, incurved, but little elevated above the hinge-line. Valves moderately convex, their greatest prominence along an oblique line from the beak to the postero-basal extremity, the umbonal prominence not at all angular; anterior slope long and gently convex, becoming somewhat compressed towards the cardinal extremity; posterior slope shorter and more abrupt, compressed towards the cardinal extremity, but less so than the anterior. Muscular impressions on the cast inconspicuous, the posterior one much the larger. Lateral hinge-teeth large and strong, horizontal in position, the anterior and posterior ones about equidistant from the beaks; cardinal hinge-teeth moderately strong. Inner free margins of the valves strongly crenate all around. Surface of the shell marked by

about 60 to 64 radiating ribs which are impressed upon the casts up to the umbonal region.

Remarks.—Whitfield's figure 17 of his *Cardium eufaulensis* is possibly a representative of this species, but it is proportionately somewhat narrower than any of the specimens which have been observed. The species differs from *C. eufaulensis* in its more nearly circular form, its straighter and practically horizontal hinge-line, and its much larger number of costæ. It is also much larger than the original illustration of that species.

Formation and locality.—Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey.

Cardium cliffwoodensis n. sp.

Plate LXIV., Figs. 1–4.

Description.—The dimensions of the internal casts of two valves, the larger a right and the smaller a left valve, are: height, 25 mm. and 18 mm.; width, 25 mm. and 18 mm.; convexity, 7 mm. and 6 mm. Shell obliquely subovate in outline; hinge-line arcuate; the anterior and basal margins from the anterior cardinal extremity to the postero-basal extremity, describe a nearly regular semicircle; postero-basal margin more sharply rounded; posterior margin gently convex, straighter than the anterior margin. Beaks situated near the middle of the hinge-line, small, acute, slightly elevated above the hinge-line in the internal casts. Valves only moderately convex; anterior slope long and regularly convex; posterior slope much shorter, more abrupt, slightly flattened. Muscular impressions on the casts inconspicuous. Lateral hinge-teeth strong, sloping slightly downward from the beak on each side; characters of the cardinal teeth not clear in the casts. Inner free margin of the shell strongly crenate. Surface of the shell marked by about 35 or 40, squarish, flat-topped, radiating costæ, slightly wider than the interspaces, and by fine concentric lines which are stronger upon the tops of the radiating costæ.

Formation and locality.—Cliffwood clay, Cliffwood Point (185), near Matawan (107).

Geographic distribution.—New Jersey.

Cardium lorillardensis n. sp.

Plate LXIV., Figs. 5–6.

Description.—The dimensions of the internal cast of a left valve are: height, 30 mm.; width, 25 mm.; convexity, 10 mm. Shell oblique, subovate to subrhomboidal in outline. Hinge-line nearly straight; anterior and basal margins curving with a gradually decreasing curvature from the anterior cardinal extremity nearly to the postero-basal extremity; postero-basal extremity more sharply rounded; posterior margin obliquely truncate, a little convex above and below, straight or nearly straight in the middle. Beaks situated at about the middle of the hinge-line, prominent, elevated above the hinge-line, acute, incurved, pointing anteriorly. Valves with a subangular umbonal prominence or ridge extending from the beak obliquely backward to the postero-basal extremity; anterior slope long and nearly regularly convex, posterior slope abrupt, usually a little concave. Surface of shell marked by about 40 or 45 angular radiating costæ a little narrower than the intervening furrows, and by very fine, concentric, sublamellose lines which are much more conspicuous upon the anterior faces of the radiating costæ.

Remarks.—This species can be easily distinguished from any other member of the genus in the New Jersey Cretaceous faunas, by reason of its subangular umbonal ridge, its obliquely truncate posterior margin, and by the peculiarity of the fine, concentric, sublamellose lines upon the surface being much more conspicuous upon the anterior faces of the costæ.

Formation and locality.—Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey.

Cardium ripleyanum Conrad.

Plate LXV., Figs. 4–6.

1869. *Cardium ripleyanum* Con., Am. Jour. Conch., vol. 5, p. 96, pl. 9, fig. 6.

1886. *Cardium ripleyanum* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9,) p. 132, pl. 20, fig. 14.

1905. *Cardium ripleyanum* Johns., Proc. Acad. Nat Sci. Phil. (1905), p. 15.

Description.—The dimensions of an internal cast are: height, 4.5 mm.; width, 4 mm.; thickness, 3 mm. The height of one of the largest individuals observed is 5.3 mm. Shell subcircular in outline, slightly higher than wide, cordate in end view. Hinge-line relatively long, a little arched; anterior, basal, and posterior margins rounded. Beaks rather prominent, elevated above the hinge-line, incurved. Umbones prominent, the surface sloping rather abruptly both in front and behind; shell compressed towards the cardinal extremities, more so behind than in front. Surface of the shell marked with about 22 subangular, radiating ribs, slightly narrower than the interspaces, also by fine, concentric, sublamellose lines.

Remarks.—This little species is not an uncommon member of the Woodbury clay fauna, being less common in the Cliffwood and Merchantville. It was originally described from the Woodbury clay formation near Haddonfield.

Formation and locality.—Cliffwood clay, Cliffwood Point (105), near Matawan (189); Merchantville clay, near Jamesburg (139, 140, 141), Lenola (163); Woodbury clay, Lorillard (102), near Matawan (103), near Haddonfield (183, 168, 165, 164).

Geographic distribution.—New Jersey.

Cardium spillmani Conrad.

Plate LXIV., Figs. 9–11.

1858. *Cardium spillmani* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 326, pl. 34, fig. 3.

1864. *Cardium* (*Liocardium*) *spillmani* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 13.

1886. *Cardium* (*Protocardium*) *perelongatum* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 136, pl. 20, figs. 20-21, pl. 21, figs. 4-5.

1886. *Pachycardium burlingtonense* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 138, pl. 21, figs. 6-7.
1905. *Cardium (Lævicardium) perelongatum* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 15.
1905. *Cardium (Lævicardium) burlingtonense* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 15.
1905. *Cardium (Lævicardium) spillmani* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 15.

Description.—The dimensions of a nearly perfect internal cast are: height, 87 mm.; width, 55 mm.; thickness, 60 mm. Shell more or less narrowly subovate in lateral view, and cordate in end view. Hinge-line rather short, arched, extending further downward in front than behind; anterior margin convex, the curvature becoming greater below; basal margin regularly rounded; posterior margin longer and straighter than the anterior, usually slightly convex, sometimes straight or slightly sinuate in the casts a little above the middle. Beaks situated back of the middle of the hinge-line, strongly elevated above it in the casts, pointed, incurved, and distinctly curved forward. Umbones prominent, the most prominent portion of the shell being in an oblique line from the beaks to the postero-basal margin, this umbonal prominence being not at all angular. The posterior slope much more abrupt than the anterior, its surface conspicuously impressed above the middle of the shell about half way between the top of the umbonal prominence and the posterior cardinal extremity. Muscular impressions large, the anterior ones deeply impressed, the posterior ones scarcely or not at all differentiated from the surface of the casts. The left valve with two strong cardinal teeth beneath the beak with a pit between, right valve with a single cardinal tooth; anterior lateral teeth more remote from the cardinal teeth than the posterior ones, and also apparently much stronger. Inner free margin of the valves crenate along the posterior margin, smooth along the basal and anterior margins. Surface of the shell marked by radiating ribs upon the posterior slope, which, in the internal casts at least, continue only from the margin up to the umbonal

prominence; central and anterior portions of the shell marked by concentric lines of growth only.

Remarks.—Both of the species described by Whitfield from New Jersey as *Cardium perelongatum* and *Pachycardium burlingtonense,* are certainly internal casts of the shell described by Conrad from Mississippi as *Cardium spillmani,* the example to which the last of the two names was applied being an exceptionally broad specimen. The species is for the most part restricted to the Navesink marl, where it attains its maximum size. The specimens which have been rarely noticed in the Merchantville clay are usually small, although Whitfield's *P. burlingtonense* is a very large example. The internal casts, in which condition the species usually occurs, have some resemblance to those of the species described in this report as *C. kümmeli,* but they are usually larger than that species, the beaks have more of a forward curvature, the anterior portion of the hinge-line is longer and extends further down towards the base of the shell, the anterior muscular impressions are lower in position, and the shell is radiately ribbed posteriorly. When the shell itself, with its external markings is preserved, it is not possible to confuse the two species.

Formation and locality.—Merchantville clay-marl (rare), near Matawan (100[4], 101); Navesink marl, Atlantic Highlands (108), near Walnford (148[2]), Crosswicks Creek (147[3], 147[4], 195), near Jacobstown (150).

Geographic distribution.—New Jersey, Alabama, Mississippi, Texas, Oklahoma.

Cardium kümmeli n. sp.

Plate LXVI., Figs. 1–3.

Description.—The dimensions of a rather small internal cast of a right valve are: height, 45 mm.; width, 34 mm.; convexity, 17.5 mm. Large individuals sometimes attain a height of 70 mm. or more. Shell subovate in lateral view, cordate in end view. Beaks of the internal casts greatly elevated above the hinge-line, pointed and incurved. Hinge-line arcuate; anterior margin regularly rounded from the extremity of the hinge-line to the

middle of the basal margin; postero-basal margin a little more sharply rounded; posterior margin convex, a little straighter than the anterior. Valves strongly convex or gibbous, most prominent, but not at all angular, along an oblique line from the beaks to the postero-basal extremity, the posterior slope more abrupt than the anterior. Muscular impressions large, the anterior ones deeply impressed above, the posterior ones scarcely differentiated from the general surface of the casts. Hinge characters not seen. Inner free margins of the valves apparently not crenate. Shell substance thick, rugose externally. The surface markings consist of strongly elevated, rounded, radiating costæ, narrower than the interspaces; on a specimen about 55 mm. in length, the distance between these ribs from center to center at the middle portion of the shell margin, is about 2 mm. or a little less. Each third interspace is occupied by a row of strong and thick spines rising one or two millimeters above the tops of the costæ when complete, subcircular in cross-section, their bases occupying the entire width of the furrow, the space between successive spines being about equal to the thickness of the spines themselves; in some cases the bases of the spines are thickened longitudinally so that they occupy essentially the entire furrow, in which case the two bounding costæ with the row of spines rising from the intervening furrow, appear to form altogether, one broad rib supporting a row of strong spines. The two furrows intervening between the rows of strong spines are each occupied by a row of very much smaller, laterally compressed spines whose bases are more or less connected.

Remarks.—There is considerable variation shown in the surface markings of different individuals of this species, and the extremes might be taken as the representatives of distinct species or even of distinct subgenera. In its typical form as seen in the Tinton beds, the species exhibits clearly the characteristics of the subgenus *Criocardium,* the rows of spines rising from the interspaces between the radiating costæ of the shell. In some specimens the bases of the larger spines or nodes are confluent and appear to entirely fill the interspace occupied by them, so that the two bounding costæ with the row of spines together seem to

constitute a single broad rib crowned with a row of strong nodes. At the same time the rows of secondary nodes are sometimes confluent at their bases and form a continuous secondary rib, perhaps nodose on top, and about equaling in height and size the primary costæ, so that there seem to be three costæ of nearly equal size in the broad interspace between the rows of large nodes and their included bounding costæ. In the extreme development of the rows of secondary nodes their bases are confluent and they increase in size and height so as to occupy the whole of the interspaces, obliterating entirely the primary costæ, so that the surface of the shell is apparently marked by radiating rows of tubercles which apparently do not rise from interspaces between costæ, but directly from the surface, each third row being much larger and stronger than the two intervening ones.

It is possible that larger collections of more perfectly preserved material than is now available, would show that more than one species has been included under this head, but so far as can be determined from present collections, all these forms seem to run together. The typical form of the species, however, is that in which the nodes rise distinctly from the interspaces, showing the characters clearly of the subgenus *Criocardium,* and which has been recognized only in the Tinton beds.

In its somewhat elongate and slender form, the species in the form of internal casts somewhat resembles the casts of *C. spillmani* and they have sometimes been so identified. It does not grow so large as that species, however, it lacks the radiating ribs usually impressed upon the posterior slope of *C. perelongatum,* and the anterior muscular scar is not so low in position.

In the collections of the National Museum at Washington this species is represented by numerous examples from the South which have usually been referred to *Cardium dumosum.* These southern specimens are perfectly preserved shells which are smaller than the usual examples from the Tinton Beds in New Jersey, but their surface markings are identical with those of the type specimen. The species differs from *C. dumosum* in its more elongate form and in the much coarser surface markings. *C. tippana* is another allied form in which the surface markings

are fully as coarse as in *C. kümmeli,* but there is only a single row of smaller tubercles between the larger ones in that species, instead of two as in *C. kümmeli.*

Formation and locality.—Navesink marl, Mullica Hill (169); Red Bank sand, near Middletown (112); Tinton beds, Beers Hill cut, south of Keyport (129^5, 129^7, 129^9), near Freehold (132).

Geographic distribution.—New Jersey, Alabama, Mississippi.

Cardium uniformis n. sp.

Plate LXV., Figs. 1–3.

Description.—The dimensions of a perfect internal cast are: height, 42 mm.; width, 35.5 mm.; thickness, 28 mm. Shell irregularly subovate in lateral view and narrowly cordate in end view. Beaks situated near the middle of the hinge-line and elevated above it, pointed and incurved. Hinge-line arcuate; anterior margin from the extremity of the hinge-line to the middle of the basal margin almost regularly arcuate; postero-basal margin more sharply rounded into the posterior margin, which is gently convex, being much straighter than the anterior margin. Muscular impressions moderately large, not strongly impressed. Inner free margins of the shell crenate, the corrugations of the external surface of the shell recognizable upon the internal casts to the umbonal region, and in small individuals to the beaks. The most prominent portion of the shell is in a line extending obliquely from the beak to the postero-basal extremity, this umbonal prominence is not at all angular, but the posterior slope is more abrupt than the anterior, becoming slightly concave as it approaches the cardinal extremity. The hinge-teeth, so far as can be recognized from the internal cast, are in every way similar to those of *C. tenuistriatum.* The surface markings, as indicated by impressions of the outside, consist of rather broad, flattened, radiating costæ, with much narrower interspaces. From the bottoms of the interspaces arise rows of spinules, very strongly compressed laterally, which are nearly uniform in size over the main central portion of the shell, there being only a slight suggestion of each third row being slightly larger; upon

the anterior slope of the shell, however, each third row of spinules, and near the cardinal extremity every other row, are materially stronger; the same condition is probably true for the posterior slope, but this has not been observed.

Remarks.—The closest ally of this species is the common shell referred to *C. tenuistriatum* in this report, but the two species differ in several respects. The radiating rows of spinules are much more uniform in size on *C. uniformis* than on *C. tenuistriatum,* although upon the anterior and probably upon the posterior lateral slope there are rows of larger and smaller spines. The valves also of *C. uniformis* are less strongly convex than those of *C. tenuistriatum,* and they are slightly compressed towards the posterior cardinal extremity and the corrugations of the exterior are more strongly impressed upon the surface of the internal casts.

Formation and locality.—Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey.

Cardium trillineatum n. sp.

Plate LXV., Fig. 20.

Description.—Form and dimensions of the shell not known, but probably similar to *C. tenuistriatum.* Surface of the shell marked with flattened radiating costæ, with interspaces about equal to or a little narrower than the costæ. From each fourth interspace, on the central portion of the shell, arises a row of laterally compressed spinules at intervals apart about equaling the width of three costæ and their two intervening interspaces; in each of the three intervening interspaces is a row of minute tubercles much smaller and much closer together than the spinules, about three or three and one-half occupying the space of two spinules. On the lateral slope of the type specimen one space between the rows of spinules is occupied by but two rows of tubercles.

Remarks.—This species is established upon a single specimen, an incomplete impression of the exterior of a shell. This fragment is about 17 mm. in length, but the specimen of which

it was a part could not have been less than 30 mm. in length. The surface markings of the shell resemble those of both *C. dumosum* and *C. tenuistriatum,* but differ from both of these species in having three lines of tubercles or smaller spinules between the rows of larger ones instead of two only, the number of rows of smaller spinules upon the lateral slopes of the shell being sometimes reduced to two instead of to one only as in both the other species. Because of our limited knowledge of this species, it is possible that some of the internal casts from the Navesink marl referred to *C. tenuistriatum* may belong here, but that can be determined only by means of more complete collections.

Formation and locality.—Navesink marl, Atlantic Highlands (108).

Geographic distribution.—New Jersey.

Cardium dumosum Conrad.

Plate LXV., 7–10.

1870. *Cardium* (*Criocardium*) *dumosum* Con., Am. Jour. Conch., vol. 6, p. 75.

1886. *Cardium* (*Cricocardium*) *dumosum* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 133, pl. 20, figs. 9 and ? 13 (not figs. 10-12).

1905. *Cardium dumosum* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 15.

Description.—The dimensions of a large individual are: height, 18 mm.; width, 18 mm.; convexity of one valve, 6 mm. Shell subcircular in outline, but slightly inequilateral, moderately convex. Beaks situated at about the middle of the hinge-line, rather small and incurved; umbones prominent, the anterior and posterior cardinal slopes about equally steep; shell slightly compressed at both cardinal extremities. Surface of the shell marked with about 54 rounded radiating costæ, with interspaces of about equal width; from the bottom of every third interspace on the central portion of the shell, there arises a row of laterally

flattened spines one to two millimeters in length, their distance apart being about equal to the space occupied by two costæ; the two intervening interspaces are occupied by rows of much smaller tubercles a little compressed laterally, situated at intervals about one-third the distance between the spines in each row. On the anterior and posterior slopes of the shell several rows of spines alternate with single rows of tubercles. The longest spines occur upon the posterior cardinal slope.

Remarks.—Because of their condition of preservation, much confusion exists among the species of *Cardium* in the New Jersey Cretaceous faunas, and several forms having the characters of the subgenus *Criocardium* have been confused. The type of this subgenus is *C. dumosum,* a species which was first described from the Woodbury clay near Haddonfield. The specimen illustrated by Whitfield in his figure 9 may be considered as typical of the species, all his other figures, with the possible exception of figure 13, probably representing other species. The species is a rather small form and may be recognized by its nearly equilateral, subcircular form, and by its straighter hinge-line than usual. From other species having similar surface markings, it may be distinguished by its narrower and rounder radiating costæ. Whitfield's figure 12, showing the surface markings enlarged, is of another species upon which the spines in each third interspace are more compressed laterally.

Formation and locality.—Woodbury clay, near Haddonfield (183), Lorillard (102), near Matawan (103); Wenonah sand, near Crawfords Corner (126[3]); Red Bank Sand, near Middletown (112).

Geographic distribution.—New Jersey.

Cardium tenuistriatum (Whitfield).

Plate LXV., Figs. 13–19.

1886. *Cardium eufaulensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 132, pl. 20, figs. 18-19, not fig. 17. (Not *C. eufaulensis* Conrad.)

1886. *Cardium* (*Criocardium*) *dumosum* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 133, pl. 20, figs. 10-12, not figs. 9 and ? 13. (Not *C. dumosum* Conrad.)

1886. *Cardium* (*Criocardium*) *multiradiatum* Whitf., Pal. N. N. J., vol. 1 (Monog. U. S. G. S., vol 9), p. 135, pl. 21, figs. 1-3. (Not *C. multiradiatum* Gabb.)

1886. *Fragum tenuistriatum* Whitf., Pal. N. J., vol 1 (Monog. U. S. G. S., vol. 9), p. 139, pl. 20, figs. 15-16.

Description.—The dimensions of an internal cast are: height, 44 mm.; width, 37 mm.; thickness, 35 mm. Large examples sometimes attain a height of over 60 mm. Shell irregularly subovate in lateral view and cordate in end view. Hinge-line arcuate; anterior and basal margins, from the extremity of the hinge-line to the middle of the basal margin, describing a nearly regular, arcuate curve; postero-basal margin curving more sharply around the postero-basal extremity of the shell into the posterior margin; posterior margin much straighter than the anterior, usually gently convex but sometimes nearly or quite straight. Beaks situated at about the middle of the hinge-line, rather prominent, elevated, pointed and incurved, considerably more prominent in the casts than in the specimens with the shell preserved. Valves gibbous, most prominent, but not angular, along a line from the beaks to the postero-basal extremity, the posterior slope more abrupt than the anterior. Muscular impressions rather large, the posterior ones scarcely impressed and often scarcely distinguishable upon the casts; the anterior ones more strongly impressed. Each valve with a strong, somewhat curved cardinal tooth beneath the beak, with a pit for the reception of the tooth of the opposite valve; in each valve is a single anterior and posterior, rather strong, lateral tooth, somewhat remote but nearly equidistant from the cardinal tooth. The inner free margin of the valves is crenate. Externally the shell is marked by flat, radiating costæ wider than the interspaces; from the interspaces rise rows of laterally compressed spinules or tubercles which are longer and stronger upon the

anterior and posterior slopes towards the hinge extremities; on the central portion of the shell each third row of processes is more conspicuous than the two intervening rows, the spines being longer and larger, one of them occupying the space of two or three of the smaller ones of the intervening rows, the smaller ones sometimes being scarcely more than tubercles but little elevated above the surface of the ribs of the shell; upon the anterior and posterior slopes of the shell the rows of larger and smaller spines alternate, there being but a single row of smaller spines between the larger ones.

Remarks.—This species is by far the commonest and most widely distributed *Cardium* in the Cretaceous faunas of New Jersey. It exhibits considerable variation, especially in the straightness of the posterior margin of the shell and in the prominence of the postero-basal extremity, but the casts can almost always be easily recognized by the strong convexity or gibbosity of the valves, and the abrupt posterior slope as compared with the anterior. The surface markings of the shell most closely resemble those of *C. dumosum,* but the radiating costæ are comparatively broader and flatter with narrower interspaces, and consequently the spines upon the surface are more compressed laterally. *C. dumosum* is also more nearly equilateral, with less convex valves than this species, and does not attain so large a size.

It has been a matter of much difficulty to determine to what species this common shell should be referred. Previous to the publication of Whitfield's monograph, it seems usually to have been referred to *C. multiradiatum* or to *C. eufaulensis.* Whitfield has apparently illustrated different individual internal casts of the species under four different specific heads. His figures 18 and 19 of *C. eufaulensis* represent a more than usually gibbous cast of this species, the true *C. eufaulensis* being a fundamentally different shell without the spines rising from the interspaces between the ribs and consequently not even a member of the sub-genus *Criocardium.* Whitfield's figures 10 and 11 of *C. dumosum* represent a more than usually rounded form of the species under discussion, the specimen is larger, more convex and

has a steeper posterior slope than the true *C. dumosum.* Figure 12 of the same author, an enlargement to illustrate the surface characters of *C. dumosum,* also proves upon examination of the specimen, to be taken from a member of the species under consideration; the illustration is not an accurate representation of the characters of the specimen, the costæ being too narrow, the interspaces too wide, and the spines not enough compressed laterally. The internal cast used by Whitfield as the orginal for his figures 1 and 2 of *C. multiradiatum* seems to be a member of this species also; a specimen in the recent collections of the Survey from the Navesink marl near Crawfords Corner agrees almost exactly with this illustration and it is undoubtedly a member of the species under discussion. The enlarged illustration, figure 3, given to represent the surface characters of this same species, is much overdrawn, the original mould from which the gutta-percha impression was taken being altogether too imperfect to show to what species it belongs.

This common New Jersey form apparently cannot be referred to any one of the three species already mentioned, but the specimen Whitfield has illustrated as the type of *C.* (*Fragum*) *tenuistriatum* is apparently a member of this species, although an undersized and rather abnormal one, and the name *tenuistriatum* is therefore taken for the species although it has to be transferred from the sub-genus *Fragum* to *Criocardium.*

Formation and locality.—Merchantville clay-marl, near Matawan (101, 100[4]), near Jamesburg (139, 140, 141), Lenola (163), Merchantville (162); Marshalltown clay-marl, near Swedesboro (177, 180), Marshalltown (190); Wenonah sand, near Marlboro (130); Navesink marl, Atlantic Highlands (108), Middletown (113), near Red Bank (120), near Crawfords Corner (126[7]), near Holmdel (128[3], 128[5], 127), Marlboro (131), Crosswicks Creek (149, 195), near Mount Laurel (166).

Geographic distribution.—New Jersey.

Cardium pilsbryi n. sp.

Plate LXV., Figs. 11–12.

Description.—Shell rather small, highest posteriorly, usually a little wider than high, the dimensions of one of the type speci-

mens being: height, 19 mm.; width, 21 mm.; convexity of one valve, 9.5 mm. Anterior margin broadly rounded, passing regularly into the moderately convex basal margin; postero-basal extremity subangular; posterior margin obliquely subtruncate or gently convex. Valves gibbous, most prominent along the rounded or subangular umbonal ridge, the post-umbonal slope abrupt, the anterior slope from the umbonal ridge convex; beaks rather small, incurved, directed anteriorly. Surface of the modified casts marked by rather fine radiating ribs.

Remarks.—This species is known only from the somewhat modified internal casts upon which the actual surface features of the shell are not preserved. The species can be distinguished from all other members of the genus in the New Jersey faunas by its comparatively small size, its low and broad form, and its strongly ventricose or gibbous valves.

Formation and locality.—Merchantville clay-marl, Lenola (163).

Geographic distribution.—New Jersey.

Cardium knappi n. sp.

Plate LXVI., Figs. 4–7.

Description.—Shell wider than high, the dimensions of the type specimen, an internal cast of a right valve, are: width, 37 mm.; height, 31 mm.; convexity, 12 mm.; length of hinge-line, 26 mm. Anterior margin broadly rounded, passing without interruption into the still more broadly rounded basal margin; postero-basal margin obtusely subangular, situated below the mid-height of the valve; posterior margin obliquely subtruncate. Umbo prominent, beaks rather broad, the anterior and posterior umbonal slopes subequal, muscular impressions of moderate strength as seen in the casts. Surface markings not observed, but the free margins of the cast are marked by crenulations which are broadest along the posterior subtruncate margin, indicating that the post-umbonal slope of the shell itself was marked by moderately fine radial ribs, the central and anterior portion of the surface being marked with still finer ribs.

Remarks.—This species is only known from the internal casts. It apparently resembled in its general form and markings, the species described from the Shark River Eocene by Conrad as *Protocardia curta*[1], but it has more rounded outlines and is less erect than that species. Both of these species were marked with fine radiating ribs over the entire surface of the shell, and can therefore scarcely be included in the genus *Protocardia*.

Formation and locality.—Hornerstown marl, near Juliustown (160); Vincentown sand, near Deal (122); Vincentown lime-sand, New Egypt (143).

Geographic distribution.—New Jersey.

Genus PROTOCARDIUM Beyrich.

Protocardium jerseyensis n. sp.

Plate LXV., Fig. 21.

Description.—Shell subglobular in form, small, the dimensions of the type specimen being: height, 8 mm.; width, 8.7 mm.; convexity of one valve, 3.5 mm. Valves obscurely subquadrangular in outline, the anterior margin rounding from beneath the beaks into the basal margin, ventral margin rounded, becoming a little straighter posteriorly and curving rather abruptly into the nearly vertically subtruncate posterior margin, post-dorsal margin nearly straight and horizontal near the beaks, bending regularly downward into the posterior margin behind. Valves regularly and strongly convex, slightly flattened in the internal casts on the post-umbonal slope. Beaks erect, nearly central in position. Surface of the shell marked by very fine, regular, concentric, depressed lines or grooves which become nearly or quite obsolete on the post-umbonal slope, also by very fine, regular, radiating costæ, which are conspicuous upon the post-umbonal slope, becoming obscure or entirely obsolete in front of the umbonal ridge.

Remarks.—This species is characterized by its small size, the specimen whose dimensions have been given being one of the

[1] See Whitfield, Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 1), p. 236, pl. 30, figs. 5-7.

largest observed. The character of the surface markings is shown in several natural impressions of the exterior.

Formation and locality.—Merchantville clay-marl, near Matawan (100[4]), near Jamesburg (140).

Geographic distribution.—New Jersey.

Genus Fulvia Gray.

Fulvia tenuis Whitfield.

Plate LXVI., Fig. 8.

1886. *Fulvia tenuis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 139, pl. 20, fig. 8.

Description.—"Shell rather small, but little exceeding an inch in length by about half that height; transversely elliptical in outline, and but moderately convex. Beaks very small, appressed, and but very slightly projecting beyond the hinge margin. Anterior end of the shell the shortest, obtusely pointed, or sharply rounded at its extremity, which is situated much above the middle of the height; posterior end more broadly rounded; basal line strongly arcuate and rapidly ascending toward the anterior part. Hinge-line but little declining on either side of the beak. Surface of the valve marked by radiating plications which are very fine at the anterior end, and gradually increase in strength to the extreme posterior margin, where they must have been fully one-sixteenth of an inch wide (the shell being broken at this point). Plications flattened obliquely, so as to give the anterior side a much greater abruptness and only about one-third the width of the posterior side. A few concentric undulations mark the surface, and very fine concentric striæ cover the entire shell." (Whitfield.)

Remarks.—This species was established by Whitfield upon a single, rather imperfect cast of a right valve, and no additional specimens have been met with in the more recent collections of the Survey.

Formation and locality.—Navesink marl, Holmdel (Whitfield).

Geographic distribution.—New Jersey.

Super-family ISOCARDIACEA.

Family ISOCARDIIDAE.

Genus ISOCARDIA Lamark.

Isocardia cliffwoodensis Weller.

Plate LXVI., Figs. 10–12.

1905. *Isocardia cliffwoodensis* Weller, Jour. Geol., vol. 13, p. 326, figs. 1-3.

1905. *Isocardia cliffwoodensis* Weller, Ann. Rep. State Geol. N. J., for 1904, p. 135, pl. 15, figs. 1-3.

Description.—Shell subovate in outline, the dimensions of two type specimens being: length, 18.5 mm. and 15.5 mm.; height, 14.5 mm. and 14 mm.; convexity of one valve, 6.5 mm. and 6.5 mm. Anterior margin rounding regularly from beneath the beak into the ventral margin or sometimes a little more sharply rounded in the middle; ventral margin broadly rounded; posterior margin rather sharply rounded below, sloping forward above to the posterior extremity of the hinge-line with a gently convex curvature. Valves ventricose on the umbo, the most prominent portion situated anterior to the middle of the shell, the beaks small, situated anteriorly, strongly incurved and directed forward; the antero-umbonal slope abrupt, the posterior slope convex, becoming more abrupt as it approaches the posterior margin. Surface of the shell smooth.

Remarks.—This species has been observed in the New Jersey collections only in the form of internal casts. Examples of the same species, however, are in the collection of the National Museum at Washington, from Corsicana, Texas, with the shell preserved. The shell substance of these specimens is very thin and the surface is marked only by fine concentric lines of growth. The species exhibits some individual variation, especially in the length of the shell, as is indicated by the measurements given above of two of the type specimens, but in all other respects the characters are quite constant.

Formation and locality.—Cliffwood clay, Cliffwood Point (105, 185), near Matawan (186, 107, 189); Woodbury clay, near Matawan (103); Wenonah sand, near Marlboro (130).

Geographic distribution.—New Jersey, Texas.

Isocardia tintonensis n. sp.

Plate LXVI., Fig. 9.

Description.—The dimensions of the type specimen are: length, 28 mm.; height, 23 mm.; convexity of one valve, 9.5 mm. Valves subtriangular in outline, with prominent umbo and strongly incurved beaks situated about three-sevenths of the length of the shell from the anterior extremity. The anterior margin rounding from beneath the beak into the ventral margin, the curvature sharpest at the most anterior point, basal margin gently convex, curving upward in front and behind, the postero-basal extremity rather abruptly rounded into the posterior margin, which is obliquely subtruncate below and curving forward above to the post-cardinal margin. Valves most prominent on and just below the umbo, the anterior slope abruptly convex; the posterior slope convex and rather gentle to the rounded umbonal ridge, beyond which it becomes very abrupt and a little concave, especially above. Surface of the internal cast smooth, the shell itself probably marked by concentric lines of growth.

Formation and locality.—Tinton beds, Beers Hill cut (129^5).

Geographic distribution.—New Jersey.

Isocardia conradi Gabb.

Plate LXVI., Figs. 13–14.

1860. *Isocardia conradi* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 393, pl. 68, figs. 21-21a.

1861. *Glossus conradi* Gabb, Synop. Moll. Cret. Form., p. 186 (130).

1864. *Glossus conradi* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 12.

1868. *Buchardia conradi* Con., Cook's Geol. N. J., p. 726.
1886. *Isocardia conradi* Whitf., Pal. N. J., vol 1 (Monog. U. S. G. S., vol. 9), p. 200, pl. 26, figs. 3-4.
1905. *Isocardia conradi* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 15.

Description.—The dimensions of the type specimen are: length, 35 mm.; height, 30 mm.; thickness, 26.5 mm. Shell subtriangular in lateral view and cordate in front view. Beaks much elevated and enrolled, situated in front of the middle of the shell. Antero-cardinal margin long and concave, sloping steeply; anterior margin short, sharply rounded; basal margin long, rather strongly convex through the greater part of its length, becoming concave near its posterior extremity; postero-basal extremity acutely subangular; posterior and post-cardinal margins continuous, very long, gently convex, sloping steeply from the beaks to the postero-basal angle. Valves strongly ventricose, with an angular umbonal ridge subparallel with the post-cardinal margin; post-cardinal slope steep; in front of the umbonal ridge is a slight sinus becoming more conspicuous towards the ventral margin, in front of the sinus the surface is somewhat regularly convex through the central part of the valve, with the anterior slope abrupt and somewhat inflected to the antero-cardinal margin. Surface of cast marked by concentric lines.

Remarks.—This species has not been met with in the recent collections of the Survey, but it was reported from Timber Creek by Gabb, at the time of his original description of the species. The type specimen in the collection of the Philadelphia Academy of Science is labeled as coming from Alabama, but its lithologic characters resemble the Timber Creek fossils, rather than those from any of the Alabama localities, and it is possible that the lable is incorrect.

Formation and locality.—Vincentown limesand, Timber Creek (Gabb).

Geographic distribution.—New Jersey ?

Super-family VENERACEA.

Family VENERIDAE.

Genus CYPRIMERIA Conrad.

Cyprimeria densata (Conrad).

Plate LXVIII., Fig. 14. Plate LXIX., Figs. 1–2.

1853. *Tellina densata* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 275, pl. 24, fig. 14.

1861. *Dosinia densata* Gabb., Synop. Moll. Cret. Form., p. 176 (120).

1864. *Dosinia densata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 13.

1866. *Cyprimeria densata* Con., Am. Jour. Conch., vol. 2, p. 102.

1886. *Cyprimeria densata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 157, pl. 22, figs. 20-21 (not fig. 19).

1886. *Lucina smockana* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 130, pl. 18, figs. 21-22.

1886. *Cyprimeria heilprini* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 160, pl. 22, figs. 14-15.

1905. *Cyprimeria densata* John., Proc. Acad. Nat. Sci. Phil. (1905), p. 16.

(Not *Dosinia densata* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 725, pl. 34, fig. 13,=*Cyprimeria* alta Con., Kerr's Geol. N. Car., App, p. 27,=*Cyprimeria excavata* Mort.)

Description.—Shell attaining a length of 81 mm., a height of 66 mm., and a thickness of 25 mm. in the type specimen, the proportion of height to length being as 1 : 1.23 in the internal cast, were the actual shell preserved the height would be somewhat greater. Beaks situated about two-fifths of the length of the shell from the anterior extremity. Anterior and basal margins rounded, posterior margin broadly truncate at nearly right angles to the longitudinal axis of the shell, posterior cardinal margin nearly straight or slightly arcuate.

Remarks.—This species is especially characterized by the broad, vertical, posterior truncation of the shell. It also attains a larger size than other species in the New Jersey faunas, although Conrad's type specimen, whose dimensions are given, is probably above the average size.

The shells described by Whitfield as *Cyprimeria heilprini* and *Lucina smockana* have the same broad posterior truncation as the type of *C. densata;* the types have been carefully examined and they do not differ in any essential respect from *C. densata* and are certainly only smaller individuals of the same species.

This species should be compared with *C. cretacea* from the Woodbury clay, but it is proportionally a somewhat higher and shorter species and the posterior truncation of the shell is much broader.

Formation and locality.—Merchantville clay-marl, Lenola (163), Burlington County (Conrad), Crosswicks (Whitfield); Navesink marl, Holmdel.

Geographic distribution.—New Jersey.

Cyprimeria excavata (Morton).

Plate LXVII., Figs. 1–6.

1833. *Cythere excavata* Morton, Am. Jour. Sci., 1st ser., vol. 23, p. 292, pl. 5, fig. 1.

1834. *Cythere excavata* Morton, Synop. Org. Rem. Cret. Gr. U. S., p. 67, pl. 5, fig. 1.

1853. *Artemis excavata* Con., Proc. Acad. Nat. Sci. Phil. (1853), p. 320.

1858. *Dosinia densata* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 325, pl. 34, fig. 13 (not *Tellina densata* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 275, pl. 24, fig. 14).

1861. *Dosinia excavata* Gabb, Synop. Moll. Cret. Form., p. 176 (120).

1864. *Cyprimeria excavata* Con., Proc. Acad. Nat. Sci. Phil. (1864), p. 212, fig. in text.

1864. *Dosinia excavata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 13.
1866. *Cyprimeria excavata* Con., Am. Jour. Conch., vol. 2, p. 102.
1868. *Cyprimeria excavata* Con., Cook's Geol. N. J., p. 727.
1875. *Cyprimeria alta* Con., Kerr's Geol. N. Car., App. p. 27.
1886. *Cyprimeria excavata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 159, pl. 22, figs. 16-17.
1886. *Cyprimeria spissa* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 160, pl. 22, fig. 18.
1905. *Cyprimeria excavata* John., Proc. Acad. Nat. Sci. Phil. (1905), p. 15

Description.—Shell, in the largest specimen observed, attaining a height of 55 mm., and a length of 60 mm. The proportions of height to length in ten individuals vary from 1 : 1.08 to 1 : 1.20. The average proportions of the ten individuals being 1 : 1.14–. The varying proportions of height to length is in no way correlated with the growth or size of the individuals. The position of the beaks varies in the same ten individuals from .32 to .47 of the length of the shell from the anterior extremity, the average position being .38+.

The anterior margin of the shell is broadly rounded, passing into the rounded basal margin, posteriorly the margin is usually obtusely subangular as it passes from the basal to the posterior region, the posterior margin being subtruncate below and directed posteriorly backward from the posterior extremity of the basal margin; at about the middle of the height of the shell, above the truncate region, the margin bends somewhat abruptly forward and passes to the beak in a long gentle curve, the curvature somewhat increasing as it approaches the beak. In some individuals the post cardinal slope is slightly humped towards the beak by reason of a rather abrupt change in the curvature. Behind the beaks the margins of the valves are strongly and abruptly inflected to form a deeply excavated escutcheon. Valves depressed convex, the left valve less convex than the right. Beaks of the two valves nearly in contact, lunule obsolete.

The surface of each valve towards the umbo is marked by fine, regular, concentric costæ for a distance of from five to ten millimeters from the beak, from five to eight of the costæ occupying the space of one millimeter. Beyond the umbonal region the surface is marked by more or less irregular concentric lines of growth, which increase in number and become stronger toward the outer margin of adult individuals. On the posterior portion of the valves an arcuate, subtriangular area extending from the beak to the sub-truncate posterior margin, is more or less sharply differentiated from the remaining surface of the valve by reason of the greater roughness of the concentric lines of growth, this region usually being more sharply differentiated in the left than in the right valve.

Remarks.—This species is well represented in the collection by specimens from near Swesdesboro preserving the shell substance. It differs from *C. densata* in the lower, narrower, and oblique posterior truncation of the shell, and from *C. cretacea* in its relatively shorter and higher form, in its larger size and its rougher concentric lines of growth and its finer concentric umbonal costæ. Besides the Swedesboro specimens the species is known from New Jersey in the form of internal casts from the Navesink marl. The specimen from the Navesink marl at Holmdel, referred to *C. spissa* by Whitfield, must also be included in this species. The type of *C. spissa* has apparently been lost or destroyed, but it probably came from the Navesink marl of the Crosswick Creek section and was probably also a member of this species.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177); Navesink marl, Arneytown (Morton and Conrad), Holmdel (Whitfield).

Geographic distribution.—New Jersey, Alabama, Mississippi, Texas, Arkansas.

Cyprimeria cretacea Conrad.

Plate LXVII., Figs. 7–8.

1860. *Sanguinolaria cretacea* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 277, pl. 46, fig. 11.

1861. *Dosinia haddonfieldensis* Lea, Proc. Acad. Nat. Sci. Phil. (1861), p. 149.

1867. *Cyprimeria cretacensis* Con., Am. Jour. Conch., vol. 3, p. 9.

1869. *Cyprimeria cretacea* Con., Am. Jour. Conch., vol. 5, p. 98, pl. 9, fig. 12.

Description.—Shell in the larger specimens attains a length of over 50 mm., and a height of over 40 mm. The proportion of height to length in eight individuals varies from 1 : 1.24 (1.18) to 1 : 1.39 (1.31), the average proportion of the eight individuals being 1 : 1.29+ (1.22+). The specimens being internal casts the height is less than that of the actual shells, and the numbers given in parenthesis above indicate the proportions when allowance has been made for this increased height of the actual shells. The proportions in parenthesis, therefore, indicate more nearly the actual proportions of the species. A plaster cast taken from a natural mould and therefore showing the actual form of the shell, has a length of 46 mm., with a height of 37.5 mm., the proportions of height to length being as 1 : 1.23–. The position of the beak in the same eight individuals vary from .32 to .45 of the length of the shell from the anterior extremity, the average position being .36+.

The anterior margin of the shell is broadly rounded, passing into the broadly rounded basal margin; posteriorly the basal margin curves upward and passes into the subtruncate posterior margin with an obtusely subangular bend; the middle of the subtruncate posterior margin is at about the mid-height of the shell, and its direction is nearly at right angles to the greatest length of the shell. Above the subtruncate posterior margin is an obtusely subangular bend beyond which the post-cardinal margin describes a steadily increasing curve to the beaks. Valves depressed convex.

The surface of the valves towards the umbo is marked by fine, regular, rounded, concentric costæ, for a distance of 10 millimeters, more or less from the beak, four or five of these costæ occupying the space of one millimeter. Beyond the um-

bonal region the surface is nearly smooth, being marked only by more or less remote concentric lines of growth.

Remarks.—This species differs from *C. excavata* in its proportionally greater length, the average proportion of length to height in the two species being 1 : 1.22– and 1 : 1.14–. On the average the beaks of the Lorillard species are slightly further forward, although this difference is only slight. The subtruncate posterior margin of the Lorillard specimens is higher than in *C. excavata,* its middle point being at about the mid-height of the shell, while in *C. excavata* it is entirely below the mid-height of the shell; the direction of this portion of the margin is also different in the two species, it being nearly vertical in the Lorillard shells and sloping backward from below in the other. The surface markings of the two species also differ, the umbonal costæ being coarser on the Lorillard specimens and the body of the shell being smoother.

This Lorillard species differs from *C. depressa* Con. (Whitfield, Figs. 11 and 12) in the higher position of the post-marginal truncation, and its different direction, it being nearly vertical instead of sloping backward from below, and in the absence of the conspicuous hump on the post-cardinal margin. The species more closely resembles *C. densata,* but it does not grow so large as that species and the posterior truncation is narrower although it has the same nearly vertical position in the two species. It is also a proportionally lower and longer shell. The specimen illustrated by Whitfield as *C. depressa* and said to have been collected at Haddonfield is quite certainly not a New Jersey specimen at all, but came from Snow Hill, North Carolina. The only species which has certainly come from the Haddonfield locality is like the Lorillard shell only smaller, and must be called *C. cretacea.*

Formation and locality.—Cliffwood clay, near Matawan (107); Woodbury clay, Lorillard (102), near Matawan (103), Crosswicks (168), near Haddonfield (183, 165); Wenonah sand, near Marlboro (130[1]).

Geographic distribution.—New Jersey.

Genus MERETRIX Lamark.

Meretrix tippana Conrad.

Plate LXVIII., Figs. 1–3.

1858. *Meretrix Tippana* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 3, p. 326, pl. 34, fig. 18.
1861. *Meretrix Tippana* Gabb, Synop. Moll. Cret. Form., p. 198 (142).
1864. *Dione tippana* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 13.
1868. *Aphrodina Tippana* Con., Am. Jour. Conch., vol. 4, p. 246, pl. 18, fig. 5.
1868. *Aphrodina Tippana* Con., Cook's Geol. N. J., p. 727.
1886. *Aphrodina Tippana* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 154, pl. 22, figs. 6-7.
1905. *Aphrodina tippana* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 16.

Description.—The dimensions of a specimen from Ripley Mississippi, preserving the shell are: height, 28 mm.; length, 35 mm.; convexity, 8 mm. Shell subovate in outline. Antero-cardinal margin concave in front of the beak, from in front of this concave portion entirely around the shell to the posterior side of the beak, the margin is convex. Beaks nearly central or in front of the center of the shell, directed forward, scarcely incurved. Valves regularly convex, the surface curving more abruptly to the cardinal margin, with a rather broad, scarcely impressed lunule in front of the beak. Hinge of the left valve with three cardinal teeth diverging from beneath the beak, the anterior one curving forward and becoming thickened below, the posterior one much more oblique than the others and more elongate. In front of the cardinal teeth is a single weak lateral beneath the lunule, parallel with the shell margin. In the right valve are two divergent, cardinal teeth, the posterior one becoming thickened below with a longitudinal sinus, beneath the lunule is a pit for the reception of the anterior lateral tooth of the opposite valve. Surface of the shell marked by fine, more or less regular, concentric lines of growth.

Remarks.—The preceding description has been drawn up from Tippah County, Mississippi specimens. In New Jersey it has only been observed in the condition of poor internal casts. These casts are similar in form and size, however, to the southern examples, and but little doubt can be entertained as to their specific identity. The species resembles *M. cretacea,* but it is a much larger shell and the hinge structure is different.

Formation and locality.—Cliffwood clay, near Matawan (107); Merchantville clay-marl, near Matawan (101), near Jamesburg (141), Lenola (163); Wenonah sand, near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey, Mississippi, Texas, Arkansas.

Meretrix cretacea (Conrad).

Plate LXVIII., Figs. 4–7.

1870. *Æora cretacea* Con., Am. Jour. Conch., vol. 6, p. 72, pl. 3, fig. 8.

1886. *Æora cretacea* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 167, pl. 23, figs. 16-17.

1905. *Æora cretacea* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 16.

Description.—Shell below medium size, the dimensions of an average example are: height, 16.5 mm.; approximate length, 23 mm.; convexity of one valve, 5 mm.; somewhat triangularly subelliptical in outline. Valves moderately convex, beaks small, situated anterior to the middle; antero-cardinal margin concave; anterior margin rather sharply rounded above, curving more gently below and passing without interruption into the broadly rounded ventral margin; posterior margin rather short, obscurely subtruncate; post-cardinal margin long, gently convex, meeting the antero-cardinal margin at the beak in an angle of about 120°. Postero-cardinal margin somewhat inflected, especially towards the beak; antero-cardinal margin inflected in front of the beak to form a shallow lunule of moderate width. Surface of shell marked by more or less

irregular, concentric lines of growth only. Hinge of the left valve with three cardinal teeth diverging from beneath the beak, the two anterior ones of about equal length, extending directly beneath the beak with a triangular pit between them, the posterior one much more oblique and more elongate. In front of the cardinal teeth is a single low lateral beneath the lunule and parallel with the shell margin. In the right valve there are two divergent, bifid cardinal teeth with a pit beneath the lunule for the reception of the anterior lateral tooth of the opposite valve.

Remarks.—This species occurs somewhat commonly in the Marshalltown clay-marl near Swedesboro with the shell substance preserved. These specimens have been compared with the types of the species and their identification is certainly correct. The species is much like *M. tippana.* It attains but little more than one-half the size of that species, however, and the hinge-teeth are different, the bifid anterior cardinal tooth of the right valve (not the left valve as stated by Conrad) being quite different from the same tooth in *M. tippana.* The species is a member of the family *Veneridae* rather than *Tellinidae,* and there seems to be no essential reason for recognizing *Æora* as a genus distinct from *Meretrix.*

Formation and locality.—Woodbury clay, near Haddonfield (183); Marshalltown clay-marl, near Swedesboro (177).

Geographic distribution.—New Jersey.

Meretrix eufaulensis (Conrad).

Plate LXVIII., Figs. 8–10.

1860. *Callista Eufaulensis* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 282, pl. 46, fig. 24.

1861. *Callista Eufalensis* Gabb, Synop. Moll. Cret. Form., p. 161 (105).

1864. *Dione eufalensis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 13.

1886. *Callista delawarensis* Whitf., Pal. N. J., vol 1 (Monog. U. S. G. S., vol. 9), p. 153, pl. 22, fig. 10 (not figs. 8-9).

Description.—The dimensions of a very perfect left valve are: height, 16 mm.; length, 19 mm.; convexity, 4 mm. Shell subovate in outline; the beaks at about the anterior third, rather small, directed anteriorly, scarcely incurved. Antero-cardinal margin concave just in front of the beak; anterior, ventral, postero-cardinal margins convex; the posterior margin broader than the anterior. Valves regularly convex, the surface sloping more abruptly to the cardinal margins; in front of the beaks is a narrow, scarcely impressed lunule. Hinge of the left valve with two cardinal teeth diverging from beneath the beak, leaving a triangular pit between, and a much thinner, more elongate tooth directed obliquely backward close up to the ligamental area; in front of the cardinal teeth is a single strong lateral tooth beneath the lunule, parallel with the shell margin. Surface of the shell marked by fine, concentric striæ of growth, those covering the area from the beak downward about 10 or 12 millimeters are very regular, the interspaces gradually increasing until the outer ones are about one-half millimeter apart. Beyond this regularly marked area the lines of growth are less conspicuous and not so regular.

Remarks.—The specimens which have been taken as typical representatives of this species are from the Marshalltown claymarl near Swedesboro, and have the shells perfectly preserved. They agree closely with Whitfield's figure 10, a specimen from Holmdel retaining the shell, but referred by that author to *Callista delawarensis.* It is not certain, however, that these are identical with Gabb's original type specimen, which was an internal cast. No internal casts have been met with in the recent collections of the Survey which seem certainly to belong to this species; in fact, it would probably be impossible to distinguish between the casts of this species and those of some other members of the genus. In the regular concentric markings of the area about the beak, these little shells from Swedesboro resemble small individuals of *Cyprimeria,* but they do not possess the bent valves of that genus, and the hinge characters are different.

Formation and locality.—Marshalltown marl, near Swedesboro (177); Wenonah sand, near Crawfords Corner (126[3]);

Navesink marl, near Walnford (148[2]), Crosswicks Creek (147[4]).

Geographic distribution.—New Jersey, Alabama.

Genus Caryatis Roemer.

Caryatis veta Whitfield.

Plate LXVIII., Figs. 11–12.

1869. *Caryatis delawarensis* Con., Am. Jour. Conch., vol. 5, p. 41, pl. 1, fig. 6. (Not *Dione delawarensis* Gabb.)

1886. *Caryatis veta* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 218, pl. 28, figs. 16-19.

Description.—The dimensions of a rather large individual are: length, 24 mm.; height, 20 mm.; thickness, 15 mm. Shell subovate in outline; the beaks large, prominent, slightly incurved, situated about one-third the length of the shell from the anterior extremity. Hinge-line arcuate; anterior margin rather narrowly rounded; basal margin convex, curving upward more rapidly in front than behind; posterior margin rounded or sometimes obscurely subtruncate; post-cardinal margin convex, sloping rather steeply from the beaks. Valves ventricose, the surface curving most abruptly to the antero-cardinal margin, and slightly inflected to the lunular depression in front of the beaks; post-umbonal surface rather abrupt, but without a distinct umbonal ridge. Surface of the casts nearly smooth the muscular impressions inconspicuous, the pallial line faint, but the deep, broad and pointed sinus, directed obliquely upward towards the lunular depression can frequently be detected. External surface of the shell rarely seen, marked by fine concentric lines of growth.

Remarks.—This species is one of the common members of the Manasquan marl fauna, and it usually occurs wherever fossils are found in this formation. Its characters are sufficiently distinct so that it need not be confused with any other shell associated with it in the same fauna.

Formation and locality.—Hornerstown marl, near New Egypt (142[1]); Vincentown limestone, near New Egypt (143), near

Alloway (196); Manasquan marl, near Farmingdale (138), near New Egypt (155), Squankum and Shark River (Whitfield).

Geographic distribution.—New Jersey.

Genus LEGUMEN Conrad.

Legumen planulatum (Conrad).

Plate LXIX., Figs. 3–7.

1853. *Solemya planulata* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 2, p. 274, pl. 24, fig. 11.
1858. *Legumen ellipticus* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 3, p. 325, pl. 34, fig. 19.
1858. *Legumen appressus* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 3, p. 325.
1861. *Legumen appressus* Gabb, Synop. Moll. Cret. Form., p. 189 (133).
1861. *Legumen ellipticus* Gabb, Synop. Moll. Cret. Form., p. 189 (133).
1861. *Legumen planulata* Gabb, Synop. Moll. Cret. Form., p. 189 (133).
1864. *Legumen appressa* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 15.
1864. *Legumen elliptica* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 15.
1864. *Legumen planata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 15.
1868. *Legumen ellipticus* Con., Cook's Geol. N. J., p. 727.
1868. *Legumen appressus* Con., Cook's Geol. N. J., p. 727.
1876. *Legumen planulatus* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 304.
1886. *Legumen planulatum* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 184, pl. 25, figs. 3-4.
1886. *Legumen appressum* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 185, pl. 25, figs. 6-8.
1886. *Legumen ellipticum* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), pl. 25, fig. 5.
1905. *Legumen planulatum* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 17.

1905. *Legumen appressum* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 17.

1905. *Legumen ellipticum* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 17.

Description.—The dimensions of two specimens are: length, 74 mm. and 34 mm.; height, 35 mm. and 15 mm. Shell subelliptical in outline, the beaks small, appressed, scarcely projecting above the hinge-line, situated about one-fourth the length of the shell from the anterior extremity. Hinge-line slightly arcuate; anterior margin more or less sharply rounded, the greatest extension at the mid-height of the shell; basal margin gently convex; posterior margin a little more broadly rounded than the anterior, the greatest extension usually a little above the middle. Valves depressed convex, without an umbonal ridge; the surface curving a little more abruptly to the cardinal margin. In internal casts the anterior muscular impression is usually well defined and is bounded posteriorly by a shallow furrow-like depression which curves forward below; the posterior muscular impression inconspicuous. Surface of the shell marked by more or less regular, concentric lines of growth which become stronger upon the posterior slope. These markings are usually impressed upon the surface of the internal casts.

Remarks.—Three species of this genus have been recognized in the Cretaceous faunas of New Jersey and the South, and two of these have been recognized by Whitfield in New Jersey. These three species, all of them described by Conrad, have been based upon very slight differences in the details of outline, and a careful study of numerous examples in the recent collections of the Survey, from several different horizons, besides the specimens in the collections at Washington and Philadelphia, has led to the conclusion that all of these forms represent a single somewhat variable species. No two specimens examined agree exactly in the outline of the shell, and there seem to be intermediate variations between all the different species which have been described. The differences in the surface markings is doubtless due to different degrees of erosion. Gabb arrived at this same conclusion regarding the three species in 1876. The hinge of

this species, as shown by material in the collection of the National Museum at Washington, is essentially the same as that of *Baroda*, and the two names are undoubtedly synonymous. *Legumen*, however, has priority over *Baroda* and must be adopted for the genus, but it must be transferred from the family *Solenidae* where it has usually been placed, and placed with the *Veneridae*, among the excessively elongate forms of that family.

Formation and locality.—Merchantville clay-marl, near Matawan (101), near Jamesburg (141), Lenola (163); Woodbury clay, Lorillard (102), Crosswicks (168), near Haddonfield (183); Wenonah sand, near Marlboro (130); Navesink marl, Atlantic Highlands (108), Crosswicks Creek (149, 195); Red Bank sand, near Middletown (112).

Geographic distribution.—New Jersey, Alabama, Mississippi, Texas, Arkansas.

Family PETRICOLIDAE.

Genus PETRICOLA Lamark.

Petricola nova-aegyptica Whitfield.

Plate LXVIII., Fig. 13.

1886. *Petricola Nova-Ægyptica* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 216, pl. 28, fig. 22.

Description.—The dimensions of the type specimen are: length, 34 mm.; height, 17.5 mm.; thickness, 10 mm. Shell subelliptical in outline; the beaks rather broad but little elevated above the hinge-line, situated about one-fourth the length of the shell from the anterior extremity. Anterior margin broadly rounded; basal margin gently convex, curving upward more abruptly in front; posterior margin more narrowly rounded than the anterior, the greatest posterior extension apparently below the middle. Valves moderately convex with no distinct umbonal ridge in the cast; the only surface markings indicated on the cast being a few concentric undulations. The posterior muscular impression of moderate size and sharply defined; the anterior scar inconspicuous; pallial line with a deep rounded pallial sinus extending beyond the middle of the shell.

Remarks.—The type specimen is the only member of this species which has been observed. It is an imperfect internal cast, the right valve being well preserved but with the left valve much injured.

Formation and locality.—Manasquan marl, near New Egypt (Whitfield).

Geographic distribution.—New Jersey.

Super-family TELLINACEA.

Family TELLINIDAE.

Genus TELLINA Linneus.

Tellina georgiana Gabb.

Plate LXX., Figs. 1–2.

1876. *Tellina (Telinella) Georgiana* Gabb, Proc. Acad. Nat. Sci. Phil., (1876), p. 307.

1905. *Tellina georgiana* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 16.

Description.—The dimensions of two specimens are: length, 32 mm. and 46 mm.; height, 16 mm. and 23 mm. Shell very broadly subtriangular in outline, the beaks nearly central, and pointing a little backward, the greatest anterior extension at about the mid-height of the shell, the greatest posterior extension considerably below the middle. The anterior and posterior cardinal margins meeting at the beak in an angle of about 140° to 150°, curving gently downward in front and behind; anterior margin rather sharply rounded; ventral margin very long and gently convex; postero-basal extremity sharply rounded or subangular; posterior margin nearly vertically subtruncate below, curving forward above and passing into the cardinal margin. Valves depressed convex, with a subangular umbonal ridge extending from the beak to the postero-basal extremity, the surface sloping with a very gentle convex curve to the anterior, posterior and ventral margins; curving much more abruptly to the cardinal margins, but just before reaching the margin the surface

is deflected in the casts so as to form a rather narrow flattened area extending from the beak in each direction and gradually dying out before reaching the anterior and posterior extremities of the shell; just beneath the beak this flattened area bears the impressions of the hinge-teeth. Surface of the casts smooth, except for a few very faint and indistinct radiating costæ just above the postero-cardinal slope of the valves. Pallial sinus very deep, extending beyond the middle of the shell. Hinge-teeth small and weak, situated just beneath the beak, a single one in the left valve with a socket on either side, and two in the right valve with a deep socket between.

Remarks.—Besides several fragments, two good internal casts of this species are present in the collection. The larger of these, a left valve, has lost the anterior extremity of the shell, and the smaller one, a right valve, is injured at its posterior extremity. Between the two, however, all the characters of the shell can be seen. Because of the imperfection of the specimen, the longitudinal dimension of the larger specimen, given above, is subject to slight error, but the smaller one is complete enough for accurate measurement. In the Wenonah sand near Marlboro several fragments of a large *Tellina*-like shell have been collected which resemble this one, the largest of which must have been about 60 mm. in length when complete. These specimens from near Marlboro, however, although internal casts, have had the external markings of the shell impressed upon them by the compression of the soft imbedding material after the solution of the shell itself. These markings are regular concentric lines from one-half to one millimeter apart. It is not possible to determine whether or not the type of the species was marked in a similar manner. These specimens have been compared with Gabb's types of the species in the collection of the Philadelphia Academy of Sciences, and there can be no question as to their specific identity.

Formation and locality.—Wenonah sand, near Crawfords Cor-Corner (126^8), ? near Marlboro (130).

Geographic distribution.—New Jersey, Georgia.

Genus PERONAEODERMA Poli.

Peronaeoderma georgiana Gabb.

Plate LXX., Figs. 4–6.

1876. *Peronæoderma Georgiana* Gabb., Proc. Acad. Nat. Sci. Phil. (1876), p. 308.

1905. *Peronæoderma georgiana* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 16.

Description.—The dimensions of a small specimen are: length, 24 mm.; height, 14.5 mm. Shell broadly subtriangular in outline, nearly equilateral, the beak nearly central in position. Anterior and posterior cardinal margins sloping nearly symmetrically, meeting at the beak in an angle of about 133°; anterior and posterior margins both sharply rounded and nearly symmetrical, the greatest extension considerably below the middle of the shell; the posterior margin sometimes appearing to be obliquely subtruncate above; basal margin gently convex throughout, curving upward a little more strongly in front and behind. Valves depressed convex, most prominent between the beaks and the center of the shell, the surface curving somewhat abruptly to the cardinal margins, very gently to the anterior, posterior and ventral margins. Upon the post-cardinal slope just within the cardinal margin and subparallel with it, is a narrow and shallow sinus which has a slight downward curvature posteriorly and becomes extinct before reaching the posterior margin. Surface of the shell marked by regular, concentric lines, two or three of which occupy the space of one millimeter.

Remarks.—This species occurs abundantly in the Wenonah sand near Marlboro, and these specimens have been compared carefully with Gabb's types of the species in the collection of the Philadelphia Academy of Science. The specimens from the two regions agree as closely as can be expected in the case of specimens so differently preserved, and the specific identity of the northern and southern forms can be assumed with certainty. There seems to be no essential generic difference between this species and the one which has been referred to *Tellina georgiana,*

and if both the species had not been given the same specific name, both would have been referred to the genus *Tellina* in the present report.

Formation and locality.—Woodbury clay, near Matawan (103); Wenonah sand, near Marlboro (130); Red Bank Sand? Shrewsbury River (119).

Geographic distribution.—New Jersey, Georgia, Texas.

Genus LINEARIA Conrad.

Linearia metastriata Conrad.

Plate LXX., Figs. 8-9.

1860. *Linearia metastriata* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 279, pl. 46, fig. 7.
1861. *Linearia metastriata* Gabb, Synop. Moll. Cret. Form., p. 193 (137).
1864. *Linearia metastriata* Meek, Check List Inv. Foss., N. A., Cret. and Jur., p. 14.
1870. *Linearia* Con., Am. Jour. Conch., vol. 6, pp. 73-74, pl. 3, fig. 11.
1886. *Linearia metastriata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 165, pl. 23, figs. 6-7.
1905. *Linearia metastriata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 16.

Description.—The dimensions of a large individual are: length, 25 mm.; height, 16 mm. Shell subelliptical in outline, depressed convex. Beaks small, appressed, but little elevated above the hinge-line, situated nearly centrally. Hinge-line a little arcuate; anterior and posterior cardinal margins meeting at the beak in an angle of about 145°; anterior and posterior margins both rounded, the anterior a little higher than the posterior; basal margin broadly convex. Valves nearly regularly convex, the surface sloping more abruptly to the cardinal margin. Surface of the shell marked by fine concentric ribs increasing regularly in size and separated by sharply depressed furrows about equaling the ribs in width; also by radiating furrows which cut through the concentric ridges, giving them more or

less the appearance of rows of discontinuous nodes, the radiating furrows are much stronger and more conspicuous upon the anterior and posterior portions of the shell, becoming fainter or sometimes almost obsolete upon the central portion, the furrows on the anterior part are further apart than upon the posterior portion of the shell.

Remarks.—The characteristic features of the surface markings of this shell make it very easily recognizable. It occurs most commonly in the form of casts of the interior and impressions of the external surface, but these latter specimens almost always retain the peculiar surface markings.

Formation and locality.—Cliffwood clay, near Matawan (107); Merchantville clay-marl, near Matawan (101), near Jamesburg (140), Lenola (163); Woodbury clay, near Matawan (103), near Haddonfield (183); Marshalltown clay-marl, near Swedesboro (177); Wenonah sand, near Marlboro (130); Red Bank sand, Red Bank (116).

Geographic distribution.—New Jersey, Arkansas.

Linearia ornatissima n. sp.

Plate LXX., Figs. 10–12.

Description.—Shell small, the dimensions of the type specimen being: length, 6 mm.; height, 4.3 mm.; nearly equilateral, broadly subtriangular in outline with the basal angles rounded; beak central; the cardinal margins meeting at the beak in an angle of about 120°, anterior and posterior margins subequally rounded, their greatest extension below the mid-height of the shell; ventral margin gently convex. Valves depressed convex, most prominent on the umbo, the surface sloping abruptly to the cardinal margins and gently to the lateral and basal margins. Surface marked by strong radiating ribs anteriorly and posteriorly, which gradually become fainter towards the median portion of the ventral margin; on the umbo and on an area extending ventrally from the umbo nearly to the basal margin, the shell is smooth; the anterior and posterior ribs do not continue to the beak but disappear along the margins of the central smooth

area; all the ribbed portion of the shell is also marked by strong, regular, concentric costæ, somewhat stronger in the depressions between the ribs than upon the ribs themselves.

Remarks.—But two specimens of this beautiful little species have been observed, casts of the interior of the shell and impressions of the exterior. It is possible that other specimens may have attained a larger size. The species may be recognized by its beautifully cancellated anterior and posterior regions separated by the smooth median area. These markings are proportionally much stronger than in *L. metastriata,* with the contrast between the extremities and the median portion of the shell much greater; besides its smaller size the species also differs from *L. metastriata* in the greater slope of the cardinal margins, and the lower position of the greatest anterior and posterior extremities of the shell. The hinge characters of the shell have not been observed, the generic identification being based solely upon its general form and ornamentation.

Formation and locality.—Woodbury clay, Lorillard (102), near Matawan (103).

Geographic distribution.—New Jersey.

Linearia contracta Whitfield.

Plate LXX., Fig. 13.

1886. *Linearia contracta* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 167, pl. 23, fig. 5.

Description.—"Shell small and moderately convex, transversely ovate in outline, broad in front and abruptly contracted behind the beaks, the anterior end forming about three-fifths of the shell's length. Beaks small and inconspicuous. Anterior end broadly rounded and the posterior more narrowly rounded. Basal line broadly curved. Surface of the shell as seen in a matrix, marked by fine radiating striæ which extend over the entire surface, but are less strongly developed on the middle of the valve. Also marked by fine concentric grooves parallel to the margin of the shell." (Whitfield.)

Remarks.—"This species differs from *L. metastriata* in being proportionally longer, in the abrupt contraction of the posterior end, in its ovate instead of oval form, greater convexity, and in being marked by radiating striæ throughout instead of having the central part of the valve nearly or quite destitute of this marking." (Whitfield.)

This species has not been met with in any of the recent collections of the Survey, and Whitfield's type specimen seems to have been lost or destroyed. It is altogether probable that the specimen was an abnormal or perhaps distorted individual of *L. metastriata*.

Formation and locality.—Navesink marl ?, Holmdel (Whitfield).

Geographic distribution.—New Jersey.

Genus TELLINIMERA Conrad.

Tellinimera eborea Conrad.

Plate LXX., Figs. 14–23.

1860. *Tellina* (*Tellinimera*) *eborea* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 278, pl. 46, fig. 14.
1861. *Tellina eborea* Gabb, Synop. Moll. Cret. Form., p. 229 (173).
1864. *Tellina* (*Tellinimera*) *eborea* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 14.
1868. *Tellinomera eborea* Con., Cook's Geol. N. J., p. 727.
1870. *Tellimera eborea* Con., Am. Jour. Conch., vol. 6, p. 73.
1884. *Tellinimera eborea* Tryon, Struct. and Syst. Conch., vol. 3, p. 169, pl. 112, fig. 100.
1886. *Tellimera eborea* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 164, pl. 23, figs. 12-13.
1905. *Tellinimera eborea* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 16.

Description.—The dimensions of an average specimen are: length, 13.5 mm.; height, 9 mm.; convexity, 2 mm. Shell tri-

angularly subovate or very broadly subtriangular, depressed convex. Beaks small, appressed, situated considerably back of the middle of the shell. Anterior and posterior cardinal slopes meeting at the beak in an angle of about 140°; anterior margin rounded; basal margin broadly convex; posterior margin subtruncate below. A rounded ill-defined umbonal ridge extends from the beak to the postero-basal extremity; the posterior slope short, more or less abrupt, often somewhat flattened; the anterior slope very long and gently convex, becoming somewhat abrupt towards the antero-cardinal margin. Surface of the shell marked by fine, concentric, impressed lines at regularly increasing distances apart, which are bent abruptly upward in crossing the umbonal ridge.

Remarks.—This species has been observed most commonly in the Wenonah sand near Marlboro, in the form of internal casts. These casts rarely retain the surface markings of the shell, but these characters can be clearly seen on the Haddonfield specimens. In its general form and size this species closely resembles the shells described as *Aenona eufaulensis,* but when the shell substance is preserved the two species may be distinguished by the presence of the fine, regular, concentric markings on *T. eborea*. *Kellia cretacea* Con.[1] is another similar species which should be compared, but no authentic specimens have been available for study during the preparation of the present report. Because of the condition of preservation of the Wenonah sand specimens referred to this species, it is not possible to determine certainly in most cases what the characters of the surface markings originally were, but the outlines of the shell seem to agree more closely with *T. eborea* than with *A. eufaulensis.*

Formation and locality.—Merchantville clay-marl, near Jamesburg (139, 140, 141); Woodbury clay, near Haddonfield (183); Wenonah sand, near Marlboro (130), near Crawfords Corner (126[3]); Red Bank sand, near Middletown (112).

Geographic distribution.—New Jersey, Alabama.

[1] Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 280, pl. 46, fig. 19.

Genus Aenona Conrad.

Aenona eufaulensis Conrad.

Plate LXX., Figs. 24-25.

1860. *Tellina Eufaulensis* Con., Jour. Acad. Nat. Sci. Phil. 2d ser., vol. 4, p. 277, pl. 46, fig. 15.
1861. *Tellina Eufalensis* Gabb, Synop. Moll. Cret. Form., p. 229 (173).
1864. *Tellina eufalensis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 14.
1870. *Ænona eufaulensis* Con., Am. Jour. Conch., vol. 6, p. 74.
1886. *Ænona Eufaulensis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 168, pl. 23, figs. 2-3.
1905. *Ænona eufaulensis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 16.

Description.—"Shell small, triangularly ovate in outline, three-fourths as high as long, with the small beaks situated a little more than one-third of the length from the anterior end. Cardinal margins rapidly sloping from the beaks, the anterior most rapidly, and the anterior end sharply rounding just above the basal line; posterior end more broadly rounded, but still narrowed; basal line broadly curved. Surface of the valve smooth and semipolished, the disk rather highly convex for a *Tellina*-like shell, with very small pointed beaks, a slight angularity of the umbonal region just in front of it, and a very narrow but distinctly circumscribed lunule. In the interior the hinge-plate is very narrow, with a single small cardinal tooth in the right valve and very small and narrow lateral teeth. Muscular markings unknown." (Whitfield).

Remarks.—This species is authentically recognized in the Cretaceous faunas of New Jersey only from Haddonfield. There are some internal casts from the Wenonah sand near Marlboro (locality 130), which more or less resemble Whitfield's illustration of this species, but they are probably all of them *Tellinimera eborea,* whose outline is similar to this species, but is proportionally higher.

Formation and locality.—Woodbury clay, Haddonfield (183).
Geographic distribution.—New Jersey, Alabama, Mississippi, Texas.

Aenona papyria Conrad.

Plate LXX., Fig. 26.

1870. *Ænona papyria* Con., Am. Jour. Conch., vol. 6, p. 74.
1886. *Ænona papyria* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 169, pl. 23, fig. 4.
1905. *Ænona papyria* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 16.

Description.—"Subelliptical, inequilateral, extremely thin in substance, convex, anterior side narrowed; posterior end obliquely truncated; ventral margin regularly curved; surface marked by microscopic concentric close lines. Length, 5/8 inch." (Conrad.)

Remarks.—The type specimen of this species in the collection of the Philadelphia Academy of Science has been much injured, in fact almost entirely destroyed, and in its present condition does not show the characters of the shell at all. The species has not been met with in the recent collections, and it apparently rests upon the single type specimen. The species seems to differ from *A. eufaulensis* in the absence of the polished surface of the shell, in the presence of the uneven, strong, concentric lines, in the flattening of the shell at the anterior end, and in the shell substance being much thinner.

Formation and localiy.—Woodbury clay, Haddonfield (183).
Geographic distribution.—New Jersey.

Super-family SOLENACEA.

Family SOLENIDAE.

Genus LEPTOSOLEN Conrad.

Leptosolen biplicata Conrad.

Plate LXX., Figs. 30–31.

1858. *Siliquaria biplicata* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 324, pl. 34, fig. 17.

1861. *Siliquaria biplicata* Gabb, Synop. Moll. Cret. Form., p. 226 (170).
1864. *Siliquaria biplicata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 15.
1867. *Leptosolen biplicata* Con., Am. Jour. Conch., vol. 3, pp. 15 and 188.
1868. *Leptosolen biplicata* Con., Cook's Geol. N. J., p. 727.
1876. *Leptosolen biplicata* Gabb, Proc. Acad. Nat Sci. Phil. (1876), p. 304.
1886. *Leptosolen biplicata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 183, pl. 25, figs. 1-2.
1905. *Leptosolen biplicata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 17.

Description.—The dimensions of an average specimen are: length, 35 mm.; height, 11 mm.; convexity, 3 mm. The largest example observed is nearly 60 mm. in length. Shell elongate, with straight, subparallel dorsal and ventral margins, the anterior and posterior margins rounded, the anterior usually a little more sharply rounded than the posterior, the greatest anterior extension at or above the mid-height of the shell. Gaping at both ends, more widely so posteriorly. Beaks small, scarcely elevated above the hinge-line, situated a little more than one-fourth the length of the shell from the anterior extremity. Valves nearly regularly convex from the dorsal to the ventral margin, the slope to the cardinal margin usually a little more abrupt; the anterior extremity of the shell compressed, with two obscure, sometimes obsolete plications extending obliquely forward and downward from the beak. In the casts a strong furrow passes from the beak downward towards the ventral margin, with a slight posterior obliquity, growing shallower below and becoming obsolete at a point about three-fourths the height of the shell from the dorsal margin. Surface of the casts marked by more or less inconspicuous concentric lines of growth.

Remarks.—This is a strongly marked species which cannot be mistaken for any other in the New Jersey Cretaceous faunas. The strong furrow extending downward from the beak in the casts represents a thickened rib upon the inner surface of the

valve, and would not be recognized upon the external surface of the shells. The species has a long geologic range in New Jersey, but it has been observed as a common species only in one locality, in the Wenonah sand near Marlboro, where is is one of the commonest members of the fauna.

Formation and locality.—Cliffwood clay, near Matawan (107); Merchantville clay-marl, near Matawan (101), near Jamesburg (141), Lenola (163); Woodbury clay, near Haddonfield (183); Wenonah sand, near Marlboro (130), near Crawfords Corner (126[3]); Navesink marl, Atlantic Highlands (108), Crosswicks Creek (195), near Jacobstown (150); Red Bank sand, Shrewsbury River (116, 119), near Middletown (112).

Geographic distribution.—New Jersey, Mississippi, Arkansas, Texas.

Leptosolen ? terminalis n. sp.

Plate LXX., Fig. 29.

Description.—The dimensions of the type specimen are: length, 19.5 mm.; height 10 mm.; convexity, 4 mm. Shell subquadrangular in outline, broadest a little back of the middle; beaks low and small, terminal. Hinge-line straight, about one-half the length of the shell; anterior margin gently convex, nearly vertically subtruncate; basal margin nearly straight, curving a little upward in front; posterior margin broadly rounded below, its greatest extension above the mid-height, above it curves far forward to the posterior extremity of the hinge-line. Valves rather strongly convex, divided nearly in half by a subangular umbonal ridge extending from the beak diagonally across the shell to the postero-basal angle; both the dorsal and ventral slopes gently convex. In the internal cast a strong and deep, sharply defined furrow passes almost directly downward from the beak towards the ventral margin of the shell, becoming shallower below and bending abruptly backward for a short distance just before reaching the margin; another similar, but narrower, furrow originates beneath the beak with the first one, and extends backward, just below the hinge-line, to a point somewhat back of the middle of the hinge-line; just within the posterior margin of the shell and parallel with it, a very nar-

row impressed line seems to have been formed by a fold of the shell from its inner surface. Surface of the cast marked by more or less irregular, concentric lines of growth.

Remarks.—This species is established upon an internal cast which resembles the casts of *Leptosolen biplicata* in the presence of the strong furrow extending towards the ventral margin from beneath the beak, but it differs in several fundamental respects from that species, and the two can hardly be cogeneric. In *L. biplicata* the shell is gaping at both ends, while in this one it is apparently closed; the beak in this shell is situated at the anterior extremity of the hinge-line, the furrow is very near the anterior margin of the shell instead of about one-fourth of the length back, and it has a distinct backward turn near the margin. The shape of the two shells is also different, the dorsal and ventral margins of *L.* ? *terminalis* diverging posteriorly.

There seems to be no genus in which this shell can be properly placed, and eventually it will probably be necessary to construct a new one for its reception.

Formation and locality.—Merchantville clay-marl, near Jamesburg (139).

Geographic distribution.—New Jersey.

Leptosolen ? elongata n. sp.

Plate LXX., Figs. 27–28.

Description.—The dimensions of the type specimen, a cast of a left valve, are: length, 24 mm.; height, 8 mm.; convexity, 2.5 mm. Shell elongate, dorsal and ventral margins subparallel; anterior margin rounded, its greatest extension above the mid-height; posterior margin probably rounded or truncate, not completely preserved. Beaks small, terminal, but little elevated above the hinge-line. Valves closed in front, apparently gaping behind; the surface regularly convex from the dorsal to the ventral margin, curving a little more abruptly above and inflected to the hinge-line in the anterior half of the shell; curving abruptly to the anterior margin in front. In the cast a strong, deep, sharply defined furrow extends downward from the beak towards the ventral margin, and a little obliquely backward, curving a little

posteriorly near its lower extremity; another much less conspicuous furrow originates beneath the beak with the first one, and extends backward, parallel with the hinge-line, becoming obsolete near the center of the shell. Surface of the cast apparently smooth.

Remarks.—This shell is not a true *Leptosolen,* but seems to be cogeneric with the shell which has been described as *Leptosolen ? terminalis.* It differs from that species in the nearly or quite parallel dorsal and ventral margins, in its greater proportional length, and in the absence of the diagonal umbonal ridge.

Formation and locality.—Red Bank sand, near Middletown (112), Red Bank (116).

Geographic distribution.—New Jersey.

Genus SILIQUA Muhlfeldt.

Siliqua cretacea Gabb.

Plate LXXI., Figs. 1–2.

1860. *Cultellus cretacea* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 303, pl. 48, figs. 24 a-b.
1861. *Siliqua Cretaceous* Gabb, Synop. Moll. Cret. Form., p. 226 (170).
1864. *Siliqua cretacea* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 15.
1868. *Ospirasolen cretaceus* Con., Cook's Geol. N. J., p. 727.
1886. *Siliqua Cretacea* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 186, pl. 25, figs. 9-10.
1905. *Siliqua cretacea* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 17.

Description.—"Shell of moderate size, the internal cast, and the only one known, being nearly one and three-fourth inches long, and for the genus very convex, rather strongly curved, and widely gaping at each extremity, the valves only coming in contact in the middle of the basal margin; posterior end most widely gaping. Beaks distinct, but not elevated, situated a little within the anterior third of the shell's length. On the cast they slightly

project above the general line of the hinge. Hinge slightly concave posterior to the beaks, and the margin considerably thickened, as indicated by the form of the cast. Anterior to the beaks the cardinal line declines at a low angle from the direction of the posterior side. Basal line very strongly curved; extremities rounded, the anterior the most sharply so. Anterior muscular scar moderately large, triangularly ovate, bordered by a rounded furrow on the posterior side, indicating a slightly thickened rib on the interior of the shell. Posterior scar larger, triangular, and faintly marked. Pallial sinus deep and extending to near the middle of the shell's length. Hinge features unknown. Indications exist on the cast of a divided tooth-like projection on the left valve, with a socket-like plate on the right." (Whitfield).

Remarks.—This species has not been met with in the recent collections of the Survey, and the type specimen described by Gabb seems to be the only example which has ever been recognized. In Whitfield's illustration of this type specimen, the furrow behind the anterior muscular scar is represented somewhat deeper than it actually is upon the specimen.

Formation and locality.—Navesink marl, Burlington county (Gabb).

Geographic distribution.—New Jersey.

Genus Solyma Conrad.

Solyma lineolata Conrad.

Plate LXXI., Figs. 3-6.

1870. *Solyma lineolatus* Con., Am. Jour. Conch., col. 6, p. 75, fig. 9.

1876. *Solyma lineolatus* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 305.

1884. *Solyma lineolatus* Tryon, Struct. and Syst. Conch., vol. 3, p. 134, pl. 105, fig. 89.

1886. *Solyma lineolata* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 182, pl. 25, figs. 11-13.

1905. *Solymya lineolata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 17.

Description.—The dimensions of the type specimen are: length, 26 mm.; height, 15.5 mm. Shell subquadrangular in outline, a little broader behind than in front; beaks broad, rather strongly elevated above the hinge-line, nearly central in position and directed anteriorly. Hinge-line nearly straight, the anterior and posterior portions sloping very gently on each side of the beak; antero-cardinal margin concave; anterior margin rounding from the cardinal into the basal margin; basal margin nearly straight or slightly convex in the middle, curving upward a little more abruptly in front than behind; postero-basal extremity rounded; posterior margin nearly vertically truncate; post-cardinal extremity obtusely subangular; post-cardinal margin straight. Valves moderately convex, with an obscure, rounded, umbonal ridge along both the anterior and posterior umbonal slopes; the cardinal margins inflected both in front and behind the beaks. Surface of both valves in the casts marked by rather fine, more or less irregular, concentric lines of growth.

Remarks.—This shell, in its general outline, somewhat resembles *Periplomya elliptica,* but with the extremities of the shell reversed, the anterior extremity of that species being the broader and the beak being directed backward. In *Solyma lineolata,* however, the posterior margin is truncate while the anterior margin of *P. elliptica* is rounded, and the anterior extremity is much broader than the posterior extremity of that shell. The two more or less obscure umbonal ridges are also a distinguishing mark of this species, but these ridges have been made too conspicuous in Whitfield's illustration of the species. Upon one of the internal casts of this species which has come under observation, there seems to be an impression of a very deep pallial sinus extending forward to the center of the shell.

Formation and locality.—Cliffwood clay, near Matawan (186); Merchantville clay-marl, near Matawan (101), near Jamesburg (139), Linola (163); Woodbury clay, Lorillard (102), near Matawan (103), near Haddonfield (183); Wenonah sand, near Marlboro (130); Red Bank sand, Red Bank (116).

Geographic distribution.—New Jersey, Georgia.

Super-family MACTRACEA.

Family MACTRIDAE.

Genus MACTRA Linneus.

Mactra pentangularis n. sp.

Plate LXXI., Figs. 7–8.

Description.—Shell subpentagonal in outline, the dimensions of the best type specimen being: height, 17 mm.; length, 18 mm.; convexity, 5 mm.; another somewhat distorted example is proportionally longer. Beaks subcentral, the cardinal margins sloping away on either side at an angle of about 122°; anterior and posterior margins both nearly vertically subtruncate, the anterior margin being slightly more convex, and both rounding below into the gently convex basal margin; greatest convexity of the valves on the median line above the middle, the surface sloping almost equally to the anterior and posterior margins, with a very slight posterior umbonal ridge. Surface marked only by fine, concentric lines of growth which become somewhat stronger and more crowded towards the margin.

Remarks.—The hinge characters of this species are not clearly shown in the casts from which it has been described, but there is an elongate lateral tooth in front of the beaks certainly, and apparently also behind; the characters beneath the beak have not been seen at all. The species differs from other Mactridae in the New Jersey faunas in the proportionally greater height of the shell and its more nearly equal height and length. The species resembles *M. nitidula* Meek[1].

Formation and locality.—Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey.

[1]Rep. on Cret. and Ter. Inv. Foss, of Up. Mo., p. 211, pl. 30, figs. 6 a.

Genus Cymbophora Gabb.

Cymbophora lintea (Conrad).

Plate LXXI., Figs. 9–13.

1860. *Cardium (Protocardium) linteum* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 278, pl. 46, fig. 17.
1861. *Cardium lintea* Gabb, Synop. Moll. Cret. Form., p. 163 (107).
1870. *Veleda lintea* Con., Am. Jour. Conch., vol. 6, p. 74.
1875. *Veleda lintea* Con., Kerr's Geol. N. Car., App., p. 9, pl. 1, fig. 26.
1876. *Cymbophora lintea* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 306.
1886. *Veleda lintea* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 18), p. 172, pl. 23, figs. 18-21.
1905. *Cymbophora lintea* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 17.

Description.—The dimensions of two separate valves of this species, the larger specimen a right and the smaller a left valve, are: length, 18.5 mm. and 16 mm.; height, 15 mm. and 13 mm.; convexity, 5 mm. and 3.5 mm. Shell ovate-subtriangular in outline. The anterior and posterior cardinal margins meeting at the beak in an angle of about 110°, curving regularly into the anterior and posterior margins below; anterior margin rather sharply rounded, its greatest extent below the mid-height of the shell; ventral margin broadly convex; posterior margin more or less sharply rounded or somewhat pointed below, oblique above, subtruncate or gently convex. Beaks a little in front of the middle of the shell or sometimes nearly central in position, slightly incurved, pointing forward, elevated a little above the hinge-line. Valves moderately convex, with a more or less obscure umbonal ridge extending obliquely from the beak to the postero-basal extremity; post-umbonal slope rather abrupt, central portion of the valve gently convex, the anterior and posterior cardinal slopes about equally abrupt. In the casts the umbonal

ridge is usually rounded, while in the shell itself it is often slightly angular. Surface of the shell marked with regular concentric lines, which are very fine in the young shells, becoming much stronger with the increased size of the shell. In the larger shells the surface markings seem sometimes to have been nearly or quite eroded, leaving the shell nearly smooth.

Remarks.—This is a common species in certain localities in New Jersey, especially in the Cliffwood clay and the Wenonah sand. Specimens from different localities exhibit considerable variation, especially in the distinctness of the concentric surface markings. The smaller and younger individuals possess these markings most clearly, but in the larger examples they seem usually to have been more or less eroded.

Formation and locality.—Cliffwood clay, Cliffwood Point (105, 185), near Matawan (107, 186, 189); Merchantville clay-marl, near Matawan (101), near Jamesburg (139, 141); Woodbury clay, near Matawan (103), near Haddonfield (164, 165, 183); Marshalltown clay-marl, near Swedesboro (177); Wenonah sand, near Crawfords Corner (126), near Marlboro (130); Red bank sand, Shrewsbury River (119), Red Bank (116), near Middletown (112); Tinton beds, Beers Hill cut, south of Keyport (129[5]).

Geographic distribution.—New Jersey, Georgia, Alabama, Mississippi, Texas.

Cymbophora tellinoides (Whitfield).

Plate LXXI., Fig. 22.

1886. *Veleda Tellinoides* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 173, pl. 23, fig. 23.

Description.—"Shell large for the genus, the cast, the only form under which it is known, being fully one and a quarter inches in length; form transversely ovate, largest at the anterior end, and two-thirds as high as long. Valves depressed convex with small appressed beaks and a slight angulation passing from the beak to the posterior extremity, forming a narrow posterior cardinal slope. Surface, as shown on the cast, marked by fine

concentric lines of growth. Muscular scars proportionally large and moderately distinct, and an indication of a rather deep sinus in the pallial line." (Whitfield).

Remarks.—"This species differs from *C. lintea* in the more transverse form, less angular umbonal ridge, which is also situated nearer to the cardinal border; in the less elevated form and more arcuate basal margin, and also conspicuously in want of the coarse, regular, concentric markings of the surface seen on that one. In regard to its generic affinities there may be a little doubt, as the hinge has been much less thickened and consequently the impressions of the teeth are less conspicuous and consequently less certain." (Whitfield).

Formation and locality.—Wenonah sand, near Marlboro (Whitfield).

Geographic distribution.—New Jersey.

Genus SCHIZODESMA Gray.

Schizodesma appressa Gabb.

Plate LXXI., Figs. 14–21.

1876. *Schizodesma ? appressa* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 306.

1886. *Veleda transversa* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 174, pl. 23, fig. 22.

1905. *Schizodesma appressa* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 17.

Description.—The dimensions of an average right valve are: length, 23 mm.; height, 15.5 mm., convexity, 4 mm. Shell inequilateral, subovate or ovate-subcuneate in outline. Anterior and posterior cardinal margins meeting at the beak at an angle of about 125°; anterior margin regularly rounding from the antero-cardinal margin above into the basal margin below; basal margin gently convex throughout, becoming a little straighter posteriorly; postero-basal extremity subangular; posterior margin shorter than the anterior, obliquely truncate; posterior cardinal extremity obtusely subangular. Beaks prominent, nearly erect, slightly incurved, situated a little in front of the middle of the shell. Valves most prominent on the umbo, sloping rather ab-

ruptly to the cardinal margins, the most gentle slope being to the postero-basal extremity; a more or less obscure rounded or subangular umbonal ridge passes from the beak obliquely backward to the postero-basal extremity. Surface of the shell marked by regular, fine, concentric lines, which become regularly stronger in passing from the beak to the shell margin, and becoming nearly obsolete upon the post-umbonal slope.

Remarks.—Gabb's type of this species has never been illustrated, but the New Jersey examples have been compared with the original specimen and their specific identity can be safely assumed. *Veleda transversa* was described by Whitfield from "dark micaceous clays below the Lower Marls at Marlborough," and the horizon indicated can be no other than the summit of the Wenonah sand as seen near Marlboro. Whitfield's type specimen has been compared with various specimens in the recent collections of the Survey, from the same horizon at a neighboring locality. These show the characters of his species and demonstrate its specific identity with Gabb's species from Georgia. The specimens from the Cliffwood clay which have been referred to the species, usually differ form the Wenonah sand examples in their somewhat higher and more vertically truncated posterior margin, these specimens also seem usually to have suffered a greater degree of erosion of the shell, which has more or less destroyed their surface markings.

Formation and locality.—Cliffwood clay, Cliffwood Point (105), near Matawan (107); Wenonah sand, near Marlboro (130), near Crawfords Corner (126^3).

Geographic distribution.—New Jersey, Georgia, Texas.

Genus RANGIA Desmoulins.

Rangia ? tenuidens (Whitfield).

Plate LXXIII., Figs. 6–8.

1886. *Gnathodon ? tenuidens* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 27, pl. 2, figs. 7-10.

Description.—"Shell of moderate size, very ventricose, very broadly ovate or subtriangular, with strong and rather tumid,

enrolled beaks, which are directed forward and project considerably beyond the line of the hinge. Posterior hinge border gently arcuate, extending more than two-thirds of the distance from the beak toward the basal margin of the shell. Postero-basal angle sharply rounded, and the basal margin broadly arched; anterior end less sharply and more regularly rounded than the postero-basal. Surface of the shell, as indicated on the partial casts and imprints left in the hardened clay, smooth or marked by fine lines of growth only. On the cast of a right valve there are indications of two principal cardinal teeth beneath the beak, and a long, rather slender, lateral tooth. The muscular impressions are not visible on the posterior side, but on one specimen the anterior scars seem to have been large and deep; but this feature is not very satisfactorily determined." (Whitfield.)

Formation and locality.—Raritan clay, Sayreville and near Woodbridge (Whitfield).

Super-family MYACEA.

Family CORBULIDAE

Genus CORBULA Lamark.

Corbula manleyi n. sp.

Plate LXXII., Figs. 1–8.

Description.—The dimensions of a perfect specimen are: length, 15 mm.; height, 10.3 mm.; thickness, 7.8 mm. Shell inequivalvate, subcuneate, subtrigonal in outline; beaks prominent, incurved, nearly in contact, situated at or a little in front of the anterior third of the shell. Anterior and posterior cardinal margins meeting at the beak in an angle of about 100°, anterior slope much shorter than the posterior; anterior margin rounding regularly from the cardinal into the basal margin; basal margin slightly convex in front, becoming straight behind; postero-basal extremity angular; posterior margin very short, curving almost immediately into the post-cardinal margin above; post-cardinal margin long, nearly straight. Valves ventricose in the umbonal region, the surface curving abruptly and inflected to the antero-cardinal margin; sloping rather steeply with a slightly convex

curve to the anterior and ventral margins, and more gently to the postero-basal extremity; each valve with an angular umbonal ridge, that of the left valve much the more conspicuous; post-umbonal slope of the right valve narrow, slightly concave, inflected to the hinge-line towards the beak; that of the left valve much broader, concave, sloping much more abruptly, not inflected. Surface of the right valve marked by rather regular, moderately fine, rounded, concentric costæ, which seem to terminate at the umbonal ridge; the left valve marked by more or less irregular concentric lines of growth which are not raised into distinct, rounded ribs, and on the anterior portion of the valve by a few indistinct radiating costæ.

On the internal casts the surface is smooth, the muscular impressions are indistinct, and the beaks are widely separated and erect. The general form and contour of the valves is the same.

Remarks.—The specimens which have been used in the description of this species were collected by Mr. John M. Manley, of New Brunswick, at Furman's clay pits, Sayreville, New Jersey. They are of special interest because they were collected from near the base of the Raritan formation, at a horizon which has rarely yielded invertebrate fossils. The species is a very peculiar and distinct one, and is quite different from any other *Corbula* in the faunas of the New Jersey Cretaceous beds.

Formation and locality.—Raritan formation, Sayreville.

Geographic distribution.—New Jersey.

Corbula lorillardensis n. sp.

Plate LXXII., Figs. 9–14.

Description.—The dimensions of an internal cast are: length, 10.5 mm.; height, 5.5 mm; thickness, 4 mm. Shell elongate subovate in outline, broader in front than behind; the beaks central or a little in front of the center, broadly obtuse, a little incurved; right valve overlapping the left along the ventral margin. Anterior and posterior cardinal margins sloping downward in front and behind the beak, meeting at an angle of about 142°; anterior margin regularly rounding from the cardinal into the basal margin; basal margin long, gently convex; postero-basal

extremity angular; posterior margin nearly vertically truncate, sometimes slightly oblique; the post-cardinal extremity angular or subangular. Surface of the valves strongly convex from the dorsal to the ventral margins, slightly convex longitudinally across the greater portion of the central part of the shell, and curving rather abruptly to the anterior margin; an angular umbonal ridge passes from the beak to the postero-basal extremity; the post-umbonal slope abrupt, usually a little concave; the posterior extremity of the right valve compressed and a little produced. Surface of the shell, as seen in impressions of the exterior, marked by rather fine, more or less irregular, concentric lines of growth, which become more conspicuous near the ventral margin and upon the post-umbonal slope. In the casts the surface is smoother, the umbonal ridge is less angular and the muscular impressions are inconspicuous.

Remarks.—This is the commonest member of the genus in the nodules at Lorillard, and can be recognized from all other species in New Jersey, by its elongate form, with the dorsal and ventral margins more or less subparallel.

Formation and locality.—Woodbury clay, Lorillard (102), near Haddonfield (164).

Geographic distribution.—New Jersey.

Corbula bisulcata Conrad.

Plate LXXII., Figs. 15–22.

1875. *Corbula bisulcata* Con., Kerr's Geol. N. Car., App., p. 11, pl. 2, figs. 13-14.

1886. *Corbula Foulkei* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 180, pl. 23, figs. 27-29. (Not *C. foulkei* Lea.)

Description.—The dimensions of a partially restored specimen, a plaster cast taken from a natural mould, are: length, 13.5 mm.; height, 8 mm.; thickness, 6.5 mm. Shell subcuneate behind, full and rounded in front. Beaks small, incurved, situated back of the middle, pointing posteriorly. Antero-cardinal

margin long, straight near the beaks and curving gently downward in front, subparallel with the basal margin; anterior margin regularly rounded; basal margin nearly straight, curving upward in front; postero-basal extremity angular; post-cardinal margin concave. Valves strongly ventricose in front, compressed behind, the ventral margin of the right valve overlapping that of the left and its posterior extremity more produced, beaks of the two valves subequal; an angular umbonal ridge is present on the right valve, with a narrow slightly concave post-umbonal slope; on the left valve the umbonal ridge is obsolete. Surface of the valves marked by rather fine, concentric lines of growth.

Perfect internal casts are subcuneate, but not so greatly produced posteriorly as the shells, the muscular impressions are conspicuous the whole area of the casts between the muscular impressions and the pallial line being strongly inflated.

Remarks.—Johnson states that the specimens from Haddonfield which were illustrated by Whitfield as *C. foulkei,* are not that species but *C. bisulcata* Con. An examination of the type specimens in the collection of the Philadelphia Academy of Sciences has confirmed the statement of Johnson. The species occurs in abundance in the Cliffwood clays, and it seems to be one of the most characteristic species in the fauna of that horizon. They occur usually in the form of internal casts, some of which are very perfect, and some good moulds of the exterior have been found. From one of these moulds, which is complete in its more essential parts, the cast used in the description of the shell was taken; the antero-basal region of the mould is lacking, but this portion of the shell has been easily restored from the form of the internal casts.

Formation and locality.—Cliffwood clay, Cliffwood Point (185), near Matawan (107, 189); Merchantville clay-marl, near Matawan (101), near Jamesburg (141), Lenola (163); Woodbury clay, Haddonfield (183).

Geographic distribution.—New Jersey, North Carolina, Mississippi, Arkansas.

Corbula foulkei Lea.

Plate LXXII., Figs. 23–26.

1861. *Corbula foulkei* Lea, Proc. Acad. Nat. Sci. Phil. (1861), p. 149.
1864. *Corbula foulkei* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 15.
1868. *Corbula foulkii* Con., Cook's Geol. N. J., p. 727.
1886. *Corbula subcompressa* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 180, pl. 23, fig. 26.
1905. *Corbula foulkei* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 17.

Description.—The dimensions of a nearly complete individual, a plaster cast taken from a natural mould, are : length, 12.5 mm.; height, 9 mm.; thickness, 6 mm. The dimensions of the perfect internal cast of the same individual are: length, 11 mm.; height, 8 mm.; thickness, 5.5 mm. Shell subtriangular in outline; the beaks slightly in front of the center, moderately incurved, pointing a little forward. Hinge-line arcuate; anterior and posterior cardinal margins sloping symmetrically on either side of the beak, and meeting at an angle of about 122°; anterior margin rounding from the cardinal into the basal margin; basal margin moderately convex, curving upward more abruptly in front than behind; postero-basal extremity angular; posterior margin obliquely truncate, meeting the post-cardinal margin in a broadly obtuse angle. Valves moderately and subequally convex, with an angular umbonal ridge; middle portion of the valve gently convex, the surface curving somewhat abruptly to the antero-cardinal margin; post-umbonal slope narrow, concave, rather abrupt. Surface of shell marked by inconspicuous lines of growth. In the internal cast the beaks are broader and blunter, and the left valve seems to be slightly more convex than the right; the muscular impressions are strongly impressed, indicating a thickening of the shell at these points, and giving to the area between them and the pallial line a somewhat inflated appearance.

Remarks.—The specimen which has been used as the basis for the preceding description is a very perfect internal cast with the accompanying natural mould of the exterior from which a cast has been taken to show the external features of the shell. This cast has the right valve complete except for a slight restoration along the ventral margin, the left valve being less complete. This specimen has been compared with the type of the species, which has never been illustrated, and the agreement is close except that the specimen here illustrated is larger. The casts of this species somewhat resemble those of *C. bisulcata,* but the central portion of that species is much more inflated, with more deeply impressed muscular impressions. Whitfield's illustration of *C. subcompressa,* on comparison with the type of that species, proves to be entirely different, and the specimen from which it was drawn is believed to be an example of *C. foulkei.*

Formation and locality.—Woodbury clay, near Matawan (103), near Haddonfield (183).

Geographic distribution.—New Jersey.

Corbula crassiplica Gabb.

Plate LXXII., Figs. 27–28.

1860. *Corbula crassiplica* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 394, pl. 68, fig. 25.
1861. *Corbula crassiplica* Gabb, Synop. Moll. Cret. Form., p. 166 (110).
1864. *Corbula crassiplicata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 15.
1868. *Corbula crassiplicata* Con., Cook's Geol. N. J., p. 727.
1875. *Corbula perbrevis* Con., Kerr's Geol. N. Car., App., p. 11, pl. 2, fig. 5.
1886. *Corbula crassiplica* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 178, pl. 23, fig. 30.

Description.—The dimensions of a right valve are: length, 6 mm.; height, 5 mm. Shell subtriangular in form. Beaks large, inflated and enrolled, situated a little in front of the middle of the

shell. Hinge-line arcuate; antero-cardinal margin sloping rather abruptly forward to the anterior extremity of the shell below the middle; basal margin convex anteriorly through the greater portion of its length, becoming concave behind; postero-basal extremity angular; posterior margin short, vertically truncate, curving rather abruptly above into the long sloping postero-cardinal margin. Right valve strongly ventricose, with an angular umbonal ridge which is faint or obsolete towards the beak, becoming conspicuous as it approaches the postero-basal angle of the shell; in front of the umbonal ridge in the lower half of the shell is a rather narrow but distinct sinus which forms the posterior sinuosity in the basal margin; the post-umbonal slope concave. Surface of the valve marked with nine or ten strong, rounded, elevated, concentric costae, which continue from the anterior margin of the shell to the sinus in front of the umbonal ridge, the interspaces about equaling the ribs in width. On the umbo the concentric markings are reduced rather abruptly from the strong costae to fine concentric lines; passing over the umbonal ridge and down the posterior slope, are rather fine, sublamellose, concentric lines of growth. Left valve much less ventricose than the right and the beak much less produced, the surface marked only with more or less irregular concentric lines without the strong costae.

Remarks.—This species has a long range in the Cretaceous beds of New Jersey, and can always be easily recognized by the peculiar markings of the right valve which can frequently be seen as impressions in the matrix. The species is quite characteristic of the Woodbury clay, in which formation it sometimes occurs in great numbers. In most of the other formations, however, it is comparatively rare. The only other New Jersey species with which it is in danger of being confused is *C. cliffwoodensis* which is much larger and lacks the sinus in front of the umbonal ridge. The species is very similar to *C. murchisonia* Lea from the Claiborne Eocene.

Formation and locality.—Merchantville clay-marl, near Matawan (101), near Jamesburg (139, 140, 141), Lenola (163); Woodbury clay, Lorillard (102), near Haddonfield (164, 165, 168, 183); Wenonah sand, near Marlboro (130), near Craw-

fords Corner (126[3]); Navesink marl, near Walnford (148[2]); Red Bank sand, Red Bank (116), near Middletown (112).

Geographic distribution.—New Jersey, Mississippi, Texas, Arkansas.

Corbula cliffwoodensis n. sp.

Plate LXXII., Figs. 29–30.

Description.—The dimensions of an internal cast of a right valve are: length, 9.5 mm.; height, 8 mm.; convexity, 3.5 mm. Shell subtriangular in outline; the beak large and broad, incurved. Hinge-line arcuate; antero-cardinal margin sloping abruptly downward to below the middle of the valve; anterior margin rounding from the anterior extremity of the hinge-line into the basal margin; basal margin convex; postero-basal extremity sharply rounded; post-cardinal margin concave. Right valve strongly ventricose in the middle, rounding abruptly to the anterior and antero-cardinal margin, with an angular umbonal ridge extending obliquely backward from behind the beak in a concavely curved line to the postero-basal extremity; post-umbonal slope abrupt, concave; the valve compressed towards the posterior extremity. Surface of the right valve marked by strong, rounded, concentric ribs, which originate at the antero-cardinal margin, grow stronger in the middle of the shell and become obsolete just before reaching the umbonal ridge; about 26 of these ribs are recognizable on a shell 8 mm. in height, which regularly increase in strength from the umbo to the ventral margin; post-umbonal slope marked only by concentric lines of growth.

Remarks.—Only the right valve of this species has been observed. It is a close ally of *C. crassiplica,* but grows much larger, with comparatively finer concentric ribs, and it lacks the distinct sulcus in front of the umbonal ridge. The species is a close analog of *C. bicarinata* Con. from the Eocene of Mississippi, having about the same relation to that species that *C. crassiplica* has to *C. murchisoni* Lea. The specimens observed are all internal casts and impressions of the exterior.

Formation and locality.—Cliffwood clay, Cliffwood Point (185).

Geographic distribution.—New Jersey.

Corbula jerseyensis n. sp.

Plate LXXII., Figs. 37–38.

Description.—The dimensions of a perfect internal cast are: length, 6 mm.; height, 4 mm.; thickness, 3 mm. The dimensions of a larger left valve are: length, 9 mm.; height, 6 mm. Shell ovate-subcuneate in outline, the ventral margin of the right valve overlapping the left; beaks subcentral, pointing slightly forward, that of the right valve a little more elevated and sharper in the cast than that of the left. Hinge-line arcuate; anterior and posterior cardinal margins sloping symmetrically from the beak, where they meet in an angle of about 120°; anterior margin regularly rounded; ventral margin gently convex; postero-basal extremity angular; posterior margin truncate below, subangular above or curving into the postero-cardinal margin. Valves gently convex in their central portion, the surface curving abruptly to the antero-cardinal border; posteriorly an angular umbonal ridge separates the body of the shell from the post-umbonal slope; post-umbonal slope short, abrupt, concave. Surface of the shell nearly smooth, marked only by fine, inconspicuous lines of growth which become a little more prominent on the post-umbonal slope. In the cast the angular umbonal ridge of the exterior of the shell is nearly or quite obsolete, and the muscular impressions are inconspicuous.

Formation and locality.—Cliffwood clay, Cliffwood Point (185).

Geographic distribution.—New Jersey.

Corbula swedesboroensis n. sp.

Plate LXXII., Figs. 33–36.

Description.—The dimensions of a nearly perfect right valve are: length, 12.5 mm.; height, 9 mm.; convexity, 3.5 mm.; a larger imperfect valve is 15 mm. in length. Shell subovate in outline; the beak in front of the middle, rather small, a little incurved, pointing forward. Anterior and posterior cardinal margins meeting at the beak in an angle of about 133°; anterior

margin regularly rounded from the cardinal to the basal margin; ventral margin gently convex, with a slight sinuosity just in front of the posterior extremity; postero-basal extremity angular; posterior margin short, truncate, slightly oblique; postero-cardinal extremity obtusely angular; postero-cardinal margin nearly straight. Right valve with a low, angular, slightly sigmoidal umbonal ridge; the most prominent portion of the valve below the beak, the surface curving somewhat abruptly to the antero-cardinal margin and more gently towards the umbonal ridge, just in front of which, in the lower half of the shell, is a shallow and inconspicuous sinus; post-umbonal slope rather gentle, concave. Surface of the valve marked by fine, concentric costæ, which become more pronounced towards the ventral margin and upon the post-umbonal slope. Left valve not known.

Remarks.—This species is described from a nearly perfect right valve, from the Marshalltown clay-marl near Swedesboro. The shell substance is preserved and all the external characters are clearly visible. The shell resembles *C. subgibbosa* Con., in general form, but has the beaks pointing forward instead of posteriorly, as in that species. It also resembles the original illustration of *C. subcompressa* Gabb, but it has the beak further forward and the posterior margin less oblique.

A single internal cast of a *Corbula* from the Cliffwood clay has been referred to this species; the beak is somewhat more obtuse, the umbonal ridge less angular, and the posterior margin somewhat narrower than in the specimen preserving the shell, but these are all differences which might be expected in a cast of the interior of the shell. Another somewhat distorted internal cast from the Woodbury clay near Haddonfield, is also placed in this same species. Both of these internal casts retain traces of the concentric surface markings, which agree closely with those of the shell itself.

Formation and locality.—Cliffwood clay, near Matawan (189); Merchantville clay-marl, near Matawan (101); Woodbury clay, near Haddonfield (165); Marshalltown clay-marl, near Swedesboro (177).

Geographic distribution.—New Jersey.

Family SAXICAVIDAE.

Genus PANOPEA Menard.

Panopea decisa Conrad.

Plate LXXIII., Figs. 3–5.

1853. *Panopæa decisa* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 275, pl. 24, fig. 19.
1861. *Glycimeris decisa* Gabb, Synop. Moll. Cret. Form., p. 181 (125).
1864. *Panopæa decisa* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 15.
1868. *Glycimeris decisa* Con., Cook's Geol. N. J., p. 727.
1868. *Panopea decisa* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 181, pl. 24, figs. 5-8.
1905. *Panopea decisa* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 18.

Description.—The dimensions of a large specimen are: length, about 80 mm.; height, 51 mm.; thickness, 35 mm. Shell more or less subelliptical in outline, widely gaping behind and closed in front. Beaks central or a little in front of the center of the shell, moderately large and incurved. Hinge-line nearly straight; anterior margin rounded, its greatest extension below the middle; basal margin nearly straight or gently convex; usually subparallel with the hinge-line; posterior margin curving more or less abruptly upward and backward from the basal margin, obliquely truncate below, rounding into the cardinal margin above. Valves rather ventricose, with a rounded, oblique, anterior, umbonal ridge becoming broader and more or less obsolete below; from the umbo the surface slopes rather abruptly in front and gently behind; from the posterior side of the beak a rather broad, shallow, indefinite sinus extends obliquely backwards towards the postero-basal angle, usually becoming obsolete in the outer portion of large individuals. Surface of the shell marked by strong, more or less irregular, concentric undulations.

Remarks.—This species has a rather long range in the New Jersey Cretaceous beds, but it is most characteristically a member of the Merchantville fauna. It reaches its largest size at this horizon, those of the higher formations rarely exceeding 50 mm. in length, and usually being even smaller than this.

Formation and locality.—Merchantville clay-marl, near Matawan (100[4], 101), near Jamesburg (140), Lenola (163); Woodbury clay, Crosswicks (168), near Haddonfield (164); Wenonah sand, near Marlboro (130); Navesink marl, Atlantic Highlands (108), near Crawfords Corner (126[7]), Crosswicks Creek (195); Red Bank sand, Red Bank (116).

Geographic distribution.—New Jersey, Alabama, Mississippi, Texas.

Panopea elliptica Whitfield.

Plate LXXIII., Figs. 1–2.

1886. *Panopea elliptica* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 219, pl. 28, figs. 24-25.

Description.—The type specimen of this species is too imperfect to allow accurate measurements, but the dimensions of the best preserved specimen which has been observed are: length, 62.5 mm.; height, 38 mm.; thickness, 27.5 mm. Shell subelliptical in outline. Hinge-line long and nearly straight; anterior margin rounded, the greatest extension at or above the mid-height of the shell; basal margin convex, curving upward in front and behind into the anterior and posterior margins; posterior margin more broadly rounded than the anterior, the greatest extension at the middle. Beaks broad and moderately prominent, pointed forward; the anterior umbonal slope more abrupt than the posterior. Valves rather strongly convex, with an indefinite, rounded, anterior umbonal ridge; posterior umbonal ridge obsolete. Surface of the cast marked by rather strong, more or less irregular, concentric undulations.

Remarks.—This species is known only from very imperfect internal casts, the most perfect of which was selected by Whitfield as the type. In his interpretation of it, the author of the species

evidently reversed the anterior and posterior extremities of the shell. It is not possible to determine from the specimen to what extent the shell was gaping, but it appears to have been nearly or quite closed in front and gaping behind. The species differs from *P. decisa* of the lower beds, in its more slender form and more rounded extremities, especially the posterior, which lacks entirely the oblique truncation.

Formation and locality.—Manasquan marl, near New Egypt (Whitfield), Medford.

Geographic distribution.—New Jersey.

Family GASTROCHAENIDAE.

Genus GASTROCHAENA Spengler.

Gastrochaena whitfieldi n. sp.

Plate LXXIII., Figs. 10–12.

Description.—Diameter of the tube 14.5 mm. at its larger, closed extremity, decreasing to 11 mm. in a distance of 22 mm. Shell broadly gaping ventrally and posteriorly, the beaks anterior; the dimensions of the type specimen are: length, 16 mm.; height, 8.5 mm. Valves somewhat twisted, subtriangular in outline, truncated behind and pointed in front, but with the anterior pointed extremity inflected almost at a right angle so that in lateral view the valves appear to be quadrangular, the dorsal margin gently convex posteriorly. A low, obtusely angular, very oblique umbonal ridge extends from the beak to the postero-basal angle, below this ridge the surface is slightly concave to the ventral margin, above it is convex nearly to the dorsal margin where it becomes a little concave. Surface of the shell marked by fine, concentric lines of growth which bend upward abruptly at the oblique umbonal ridge; upon the ventral region and especially upon the inflected anterior extremities of the valves, the markings become somewhat sublamellose.

Remarks.—This species is based upon a single very perfect cast of a complete shell, with a partial impression of the external surface showing the surface markings. A cast of the inner por-

tion of the tube was also originally preserved, but this has been partially destroyed in removing the shell. The tube differs from those in the Vincentown limesand which have been described as *G. americana,* and of which the shell has never been observed, in its less slender form and in the absence of the conspicuous, irregular annulations.

Formation and locality.—Navesink marl, Bruere's pits, near Walnford (195).

Geographic distribution.—New Jersey.

Gastrochaena linguiformis n. sp.

Plate LXXIII., Fig. 9.

Description.—Tube of the type specimen with a diameter of 11 mm. Dimensions of the right valve: height 7.3, mm.; length, about 19 mm. Valves of the shell linguiform, the dorsal and ventral margins nearly straight and subparallel, the posterior margin regularly rounded, the anterior margin not preserved in the type. Right valve gently convex throughout, the left valve a little more convex and somewhat twisted. Valves marked by concentric lines of growth.

Remarks.—This species may be easily distinguished from *G. whitfieldi* by its more elongate and linguiform valves and the rounded posterior margin.

Formation and locality.—Merchantville clay-marl, near Jamesburg (140).

Geographic distribution.—New Jersey.

Gastrochaena americana Gabb.

Plate LXXIII., Fig. 13.

1860. *Gastrochæna Americana* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 393, pl. 68, fig. 20.

1861. *Gastrochæna Americana* Gabb, Synop. Moll. Cret. Form., p. 180 (124).

1861. *Polorthus Americana* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 367.

1864. *Gastrochæna americana* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 15.

1864. *Polarthus americanus* Meek, Check List Inv. Foss N. A., Cret. and Jur., p. 16.

1872. *Polorthus Americanus* Gabb, Proc. Acad. Nat. Sci. Phil. (1872), p. 259, pl. 8, fig. 8.

1886. *Gastrochæna Americana* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 203, pl. figs. 17-18.

1905. *Gastrochæna americana* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 18.

Description.—Tubes solitary, elongate-conical, the larger extremity rounded; attaining a length in the largest examples of 75 mm., and a maximum diameter of about 12 mm.; the minor diameter is usually about 5 or 6 mm.; diameter increasing gradually and more or less irregularly, usually being 1 mm. in a length of from 6 mm. to 16 mm. Surface irregularly marked by annular wrinkles and constrictions arising from what have been the rounded extremity of the tube at different stages of its growth. Some specimens have almost the appearance of worn specimens of *Orthoceras,* but with the septa convex towards the larger instead of the smaller extremity. No remains of a bivalve shell have ever been observed.

Remarks.—This species, with Morton's *Teredo tibialis* were placed by Gabb in his genus *Polorthus.* The two species agree in being the tubes of some form of boring mollusk of which no bivalve shell is known, and apparently in having the tube septate. In the details of their structure the two forms are very different, and it can be hardly possible that they are really cogeneric. Inasmuch, however, as it is not possible to determine the exact generic relations of these tubes at the present time, it seems best to continue them under the name *Gastrochaena,* the genus to which they were first ascribed and to which they have been most commonly referred.

Formation and locality.—Vincentown limesand, New Egypt (143), Timber Creek (Gabb).

Geographic distribution.—New Jersey.

Super-family ADESMACEA.

Family PHOLADIDAE.

Genus PHOLAS Linneus.

Pholas cithara Morton.

Plate LXXIV., Fig. 7.

1834. *Pholas cithara* Morton, Synop. Org. Rem. Cret. Gr. U. S., p. 68, pl. 9, fig. 10.
1852. *Pholas pectrosa* Con., Proc. Acad. Nat. Sci. Phil. (1852-53), p. 200.
1854. *Pholas pectrosa* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 299, pl. 27, fig. 9.
1861. *Pholas cithara* Gabb, Synop. Moll. Cret. Form., p. 222 (166).
1864. *Pholas cithara* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 16.
1868. *Clavipholas cithara* Con., Cook's Geol. N. J., p. 728.
1876. *Martesia cithara* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 304.
1886. *Pholas cithara* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 187, pl. 25, figs. 14-16.
1905. *Pholas pectrosa* John., Proc. Acad. Nat. Sci. Phil. (1905), p. 18.

Description.—Shell subovate in outline, sometimes more or less pointed posteriorly and subtruncate anteriorly, giving to it a subtriangular outline. Hinge-line straight, one-half or more than one-half the length of the shell; anterior margin rounded, basal margin gently convex, straight or sometimes slightly sinuate; postero-ventral extremity more or less sharply rounded, postero-dorsal margin oblique, gently convex to the posterior extremity of the hinge-line. Beaks situated about one-sixth of the length of the shell from the anterior extremity, rather broad, enrolled and approximate. Valves most prominent along a line extending almost vertically from the anterior side of the beak to the ventral margin of the shell; from this rounded umbonal prominence the surface slopes abruptly to the anterior margin

and gently to the posterior, giving to the shell a strongly cuneate outline when viewed from the ventral or dorsal aspect. In the casts a slit-like groove or shallow incision passes from the posterior side of the beak obliquely backward to about the middle of the ventral margin. In front of this incision, between it and the umbonal prominence, the surface of the valve is depressed in a shallow, ill-defined sinus which is sometimes nearly or quite obsolete. Surface of the shell marked by distinct, concentric, band-like ridges which become fainter posteriorly, becoming nearly or quite obsolete before reaching the postero-dorsal margin. Marked also by radiating ribs which are strong and somewhat distant in front, becoming fainter and closer together back of the umbonal prominence, and again stronger and more distinct back of the oblique incision; upon the postero-dorsal slope they become obsolete. At the junction of the concentric and radiating ribs flattened nodes are formed.

The dimensions of a nearly complete right valve are: length, 27.5 mm.; height, 16 mm.; convexity, 8 mm.

Remarks.—This species seems to have a long range in the Cretaceous beds of New Jersey, but it is always rare. The individual illustrated by Whitfield from Tinton Falls is narrower behind and more triangular in outline than is usual.

Formation and Locality.—Merchantville clay-marl, near Matawan (101); Woodbury clay, Lorillard (102), Crosswicks (168); Wenonah sand, near Crawfords Corner (126[3]), near Marlboro (Whitfield); Tinton beds, Tinton Falls (Conrad); ? Vincentown limesand (Whitfield).

Geographic distribution.—New Jersey, Mississippi.

Genus Turnus Gabb.

Turnus kümmeli n. sp.

Plate LXXIV., Figs. 4–6.

Description.—Tubes penetrating masses of wood, exceedingly tortuous and contorted, gradually increasing in size from their point of origin and so far as observed, reaching a maximum

diameter of 9 mm. The dimensions of a large shell are: length, 10 mm.; height, 9 mm.; depth of one valve, 5.5 mm. The hinge-line is about .7 of the total length of the shell. In anterior view the shell is cordate in outline, each valve being irregularly sub-ovate in lateral view. Beaks in front of the middle of the shell, pointed and strongly incurved, umbones very prominent, the valves compressed posteriorly and not gaping. The antero-basal hiatus rectangular, large and deep, occupying nearly the entire anterior side of the shell, its upper margin two-thirds the total height of the shell from the ventral margin. Ventral and posterior margins rounded. Umbonal sulcus deep and narrow and slightly oblique, on each side the surface of the valve is raised in a slight rib which becomes stronger, especially the posterior one, towards the ventral margin of the valve. In the internal cast a shallow ill-defined furrow originates on the posterior side of the beak and extends obliquely backward towards the postero-ventral margin, becoming almost obsolete as it approaches the margin. On the anterior side of the beak a narrower and shallower, but more sharply defined furrow originates and continues to the inner angle of the anterior hiatus of the valve. The finer surface markings are not well shown upon the internal cast, but they apparently consist of fine and inconspicuous lines of growth.

Remarks.—This species is a member of Meek's subgenus *Goniochasma*. The type specimens are from the same fragment of fossil wood which has furnished the examples of *Martesia cretacea*. The largest one has occupied a burrow, now filled with sand and pyrite, 9 mm. in diameter, whose direction is with the grain of the wood nearly in the center of the specimen. The tubes of this species are essentially identical with those of *Teredo irregularis,* and without knowledge of the shells themselves the two forms cannot be distinguished. The burrows of *Martesia cretacea,* however, are all normal to the surface of the wood which they penetrate only a short distance deeper than the length of the shells.

A single example of the species has been observed from the Merchantville formation at Lenola. This specimen is a smaller one, only 6.5 mm. in length, and is a very imperfect internal cast. So far as can be determined it has essentially the same form and

proportions as the type, but the two furrows originating upon the anterior and posterior sides of the beak can not be detected, and seem to have been absent. This may be due to the smaller and possibly younger shell.

A little shell from Corsicana, Texas, in the collection of the National Museum at Washington, is apparently identical with the New Jersey specimens.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177); Merchantville clay-marl, Reeves' clay pit, Lenola (163).

Geographic distribution.—New Jersey, Texas.

Genus MARTESIA Leach.

Martesia cretacea Gabb.

Plate LXXIV., Figs. 8–11.

1860. *Pholas cretacea* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 393, pl. 68, fig. 18.
1861. *Pholas cretacea* ? Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 324.
1864. *Pholas cretacea* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 16.
1868. *Pholas ? cretacea* Con., Cook's Geol. N. J., p. 728.
1876. *Martesia cretacea* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 304.
1886. *Martesia (Pholas) cretacea* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 190, pl. 25, figs. 20-23.
1905. *Pholas cretacea* John., Proc. Acad. Nat. Sci. Phil. (1905), p. 18.
1905. *Martesia cretacea* John., Proc. Acad. Nat. Sci. Phil. (1905), p. 18.

Description.—Shell small, subhemispherical in front, cuneate behind, the beaks strongly incurved, umbones prominent. The anterior margin rounding regularly from the anterior extremity

of the hinge-line into the straight basal margin, posterior margin subtruncate, post-cardinal margin sloping backward from the posterior extremity of the hinge-line. Surface of each valve marked by a deep, narrow groove, extending from the beak obliquely backward to the ventral margin which it meets in front of the middle of the shell; in most individuals a second groove close to and parallel with the first, but a little wider and shallower, is introduced a short distance below the beak and continues to the margin. The anterior region of the shell is marked by fine costæ which bend abruptly upward in front of the oblique grooves, continuing to above the middle of the shell, where they make a nearly rectangular turn and continue in a horizontal direction to the anterior margin, surrounding two sides of, and sharply differentiating, a smooth, triangular, slightly raised area in the antero-ventral region of each valve. The posterior region of the shell is marked by broader, rounded costæ, parallel with the margin of the valves.

The dimensions of a specimen of average size are: length, 7 mm.; height, 4.5 mm.; greatest thickness, 4.8 mm.

Remarks.—The name *Pholas cretacea* was originally applied to a group of casts of the tubes of one of the *Pholadidae,* without any knowledge of the shell characters. At a later date the original author of the species described a single individual of a shell and referred it to the same species as the previously described tubes "because it is of about the proper size to form such tubes." In themselves, the tubes of this group of pelecypods possess no characters which can be used for specific determination, and consequently the species *Pholas cretacea,* afterwards referred to the genus *Martesia,* may be considered as founded upon the shell described by Gabb. Whitfield has illustrated Gabb's specimen and redescribed it, but he saw no additional specimens. In the recent collections of the Survey 50 or more individuals of this species have been observed in a fragment of fossil wood from 1 to 1½ inches in diameter and 8 inches long. The entire surface of this wood is filled with the burrows of this species, and in each burrow is a well preserved shell or the internal cast of a shell. These specimens show some variation in several charac-

ters, but a comparison with Gabb's type of *M. cretacea* has shown them to be not essentially different from that species. Some of the examples are shorter than usual and consequently taper more abruptly to the posterior extremity than the average form, but the most important variation is the presence or absence of the supplementary oblique furrow in front of the primary one extending from the beak to the ventral margin. In the majority of individuals this furrow is present and its absence is more apt to be a feature of the smaller and presumably younger shells. In a few specimens of nearly maximum size this furrow is nearly obsolete, being noticeable only near the ventral margin, and in one specimen it is absent from one valve although faintly indicated on the other.

Formation and locality.—Merchantville clay-marl, Lenola (163); Marshalltown clay-marl, near Swedesboro (177).

Geographic distribution.—New Jersey.

Family TEREDINIDAE.

Genus TEREDO Linneus.

Teredo irregularis Gabb.

Plate LXXIV., Figs. 1–3.

1834. *Teredo tibialis* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 68 (in part).
1860. *Teredo irregularis* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 393, pl. 68, fig. 19.
1861. *Teredo contorta* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 323.
1861. *Teredo irregularis* Gabb, Synop. Moll. Cret. Form., p. 230 (174).
1864. *Teredo contorta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 16.
1864. *Teredo irregularis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 16.
1868. *Teredo contorta* Con., Cook's Geol. N. J., p. 727.
1868. *Teredo irregularis* Con., Cook's Geol. N. J., p. 727.

1886. *Teredo irregularis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 191, pl. 25, figs. 18-19.

1905. *Teredo irregularis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 18.

1905. *Teredo contorta* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 18.

Description.—Tubes as shown by their casts gregarious, exceedingly tortuous and contorted, sometimes annulated, increasing gradually in size from their point of origin, the larger ones reaching a diameter of 10 mm. or more. Shell subglobular, cordate in outline from in front, the beaks a little in front of the middle of the hinge-line, widely gaping behind and open in front; the postero-cardinal extremity somewhat produced in a rounded lobe. Anterior margin rounding from the hinge-line above into the upper margin of the large, deep, subrectangular, antero-basal hiatus which reaches above the mid-height of the shell; basal margin short; posterior margin obliquely subtruncate below, bent abruptly backward near the hinge-line, and continuing around the postero-cardinal lobe of the shell. Valves ventricose, the beaks prominent, much elevated above the hinge-line and strongly incurved or enrolled; the surface curving steeply towards the antero-cardinal extremity and then deflected shortly before reaching the margin, curving less abruptly to the postero-cardinal extremity. In the casts a very deep and prominent furrow passes from the hinge-line just back of the beaks to the posterior margin just below the post-cardinal lobe of the shell; another faint groove which is less conspicuous upon the larger individuals, crosses the post-umbonal slope in a nearly vertical direction from the lower margin of the deep groove already described behind the beaks to the posterior extremity of the basal margin; surface of the anterior half of the shell, as shown in impressions of the exterior, marked by exceedingly fine, regular, concentric striæ, parallel with the shell margin, 20 or more of which occupy the space of 1 millimeter. These striæ towards the antero-cardinal extremity, are crossed by finer radiating striæ, which produce an exceedingly fine reticulate pattern upon the

shell surface. Markings of the posterior half of the shell unknown.

Remarks.—Casts of the irregular burrows of this species are sometimes of common occurrence in the Merchantville clay, penetrating masses of fossil wood, and on tracing these burrows to their termination casts of the shell can usually be found, sometimes in excellent condition. Some masses of the tubes are all much smaller than those in other masses, but all the tubes in one group are usually of approximately the same dimensions. It was at first thought possible that the different sized tubes indicated different species, but the shells are all essentially the same, whether from large or small tubes, in all masses observed in the Merchantville clay-marl. A mass of essentially identical tubes has been found in the Marshalltown clay-marl, however, associated with many individuals of *Martesia bisulcata,* which have a very different shell, described in this report as *Turnus kümmeli.* Other similar tubes occur sometimes in the Navesink marl, but the accompanying shells have not been observed, these tubes, however, seem to be straighter, and they probably belong to another species.

The type specimen of *T. irregularis* is without data as to locality or horizon, and the description of the shell itself is too meagre to be of any use in identification. Inasmuch, however, as the Merchantville clay-marl is the horizon where burrows of this sort most frequently occur, and as Gabb described numerous fossils from this horizon in Burlington County, New Jersey, it is altogether probable that the type specimen is specifically identical with the shell here described.

Morton evidently applied the name *Teredo tibialis* to all the Teredo-like tubes he found in New Jersey, but the name is still retained for the tubes like those which he illustrated, which are found only in the Vincentown limesand. The specimens which he referred to from "the friable marls" which are preserved as "casts in lignite" were in all probability representatives of the species *T. irregularis.*

The type of *Teredo contorta* Gabb, which is preserved in the collection of the Philadelphia Academy of Science, has been care-

fully compared with the recently collected examples which are here referred to *T. irregularis,* and there can be no doubt as to their specific identity; it also is without doubt a Merchantville clay-marl specimen, and it is safe to conclude that it is a synonym of *T. irregularis.*

Formation and locality.—Merchantville clay-marl, near Matawan (101), Lenola (163).

Geographic distribution.—New Jersey, Arkansas.

Teredo species undertermined.

At Mullica Hill some *Teredo*-like borings in a fragment of wood have been observed, which strongly resemble *T. irregularis,* and from the tubes alone might be so identified. They seem to be somewhat straighter, however, than the typical forms of *T. irregularis* from the Merchantville clay-marl, and in the absence of any knowledge of the shell which inhabits them, it is not possible to identify them with certainty. In the Marshalltown clay-marl *Teredo*-like burrows have been observed which are even more like those of *T. irregularis,* but the shell inhabiting them is quite different from that species, and it is therefore more than probable that these Navesink specimens belong to another species.

Formation and locality.—Navesink marl, Mullica Hill (169).

Geographic distribution. New Jersey.

Genus Polorthus Gabb.

Polorthus tibialis (Morton).

Plate LXXIV., Figs. 12–15.

1834. *Teredo tibialis* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 68, pl. 9, fig. 2.

1861. *Teredo tibialis* Gabb, Synop. Moll. Cret. Form., p. 230 (174).

1861. *Polorthus tibialis* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 366.

1864. *Teredo tibialis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 16.
1868. *Teredo tibialis* Con., Cook's Geol. N. J., p. 727.
1872. *Polorthus tibialis* Gabb, Proc. Acad. Nat. Sci. Phil. (1872), p. 259, pl. 8, figs. 1-7.
1886. *Teredo tibialis* Whitf., Pal. N. J., vol. 1 (Monog. U. S. G. S., vol. 9), p. 201, pl. 26, figs. 19-22.
1905. *Teredo tibialis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 18.

Description.—Tubes usually compactly massed together in layers which are sometimes as much as 6 inches in depth and of considerable lateral extent, apparently penetrating sand alone. Tubes calcareous, gradually increasing in size from a diameter of less than 1 mm., to a maximum diameter of about 6 mm.; usually more or less irregularly constricted at intervals; straight or more or less wavy throughout the greater part of their length, sometimes throughout, but often becoming bent and contorted towards their larger extremity, which is always rounded. In the smaller extremity of the tube, in the terminal 5 or 6 mm., is a series of six to eight transverse septa, convex towards the smaller extremity of the tube, perforated centrally by an elliptical slit of greater or less size; the smaller extremity of the tube often constricted longitudinally so as to form a double opening; just below the terminal series of septa the casts exhibit a continuous annular muscular scar with two long inverted U-shaped prolongations towards the aperture on opposite sides, and similar U-shaped backward extensions between. Towards the larger extremity of the tubes there are from one to three, more or less remote, transverse septa, convex towards the larger extremity of the tube.

Remarks.—This species sometimes forms large masses in the Vincentown limesand, and differs from the *Teredo*-like tubes found in the lower formations of the Cretaceous beds of New Jersey in apparently having the habit of boring into the sand of the sea bottom instead of into masses of wood. The tubes also differ from those of the lower beds in the presence of transverse septa of two sorts, and in the entire absence of any bivalve shell.

Because of these peculiar characters, Gabb proposed the generic name *Polorthus* for these tubes, and expressed the belief that they were allied to the gastropod genus *Vermetus;* later, however, the same author considered the genus *Polorthus* to be a very peculiar type of Cephalopod. Both these interpretations of the tubes, however, are certainly erroneous, and there can be no question as to their relationship with the burrowing pelecypods *Teredo.* They are certainly distinct generically, however, from the casts of tubes with contained bivalve shells in the lower beds, and Gabb's generic name *Polorthus* may be retained for them. Among the living *Teredidae* there are forms with septate tubes similar to those of this Cretaceous form; some do not possess calcareous valves, and some burrow in the sand as these seem to have done, instead of in wood or stone.

Formation and locality.—Vincentown limesand, near Hurffville (170, 171), Timber Creek and near New Egypt (Whitfield).

Geographic distribution.—New Jersey.

Class SCAPHOPODA.

Family DENTALIIDAE.

Genus DENTALIUM Linneus.

Dentalium subarcuatum Conrad.

Plate LXXV., Figs. 1–2.

1853. *Dentalium subarcuatum* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 2, p. 276, pl. 24, fig. 13.

1860. *Dentalium Ripleyanum* Gabb, Jour. Acad. Nat. Sci. Phil. 2nd ser., vol. 4, p. 393, pl. 69, fig. 48.

1861. *Dentalium subarcuatum* Gabb, Synop. Moll. Cret. Form., p. 105 (49).

1864. *Dentalium subarcuatum* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 17.

1868. *Dentalium subarcuatum* Con., Cook's Geol. N. J., p. 728.

1892. *Dentalium subarcuatum* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 166, pl. 20, figs. 19-24.

1905. *Dentalium subarcuatum* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 18.

1905. *Dentalium ripleyanum* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 18.

Description.—Shell small, usually preserved in the form of casts, in which condition it is circular in cross section, gradually tapering, slender, and gently arcuate; a large individual 47 mm. in length has a maximum diameter of 5 mm., and a minimum diameter of 2 mm. Surface of the casts smooth or with faint, longitudinal ridges; when perfectly preserved they are marked along the median line of the dorsal or concave side by a slightly elevated, rounded ridge with a flattened area on each side, and upon the ventral side by a pair of depressed lines. Surface of the shell marked externally, as shown by impressions of the outside, by about 12 angular, longitudinal ribs, and by fine annular striæ.

Remarks.—In the recent collections this species has been seen most commonly in the Woodbury clay at Lorillard, where it occurs in the condition of internal casts with the external impressions of the shell preserved in the matrix. These specimens are certainly identical specifically with the example having the shell partially preserved which has been figured by Whitfield. The type of the species is an internal cast, apparently from the Merchantville clay-marl, which shows faint indications of the external longitudinal ribs. The Woodbury clay specimens agree with the type in curvature and in dimensions, and their identification with *D. subarcuata* is doubtless correct, since the same form is certainly known to be present in the Merchantville faunas. The example described by Gabb from Alabama as *D. ripleyana* seems not to be specifically distinct from the New Jersey shells.

Formation and locality.—Merchantville clay-marl, near Matawan (101), near Jamesburg (141), Lenola (163), Merchantville (162); Woodbury clay, Lorillard (102), near Matawan (103), Crosswicks (168), near Haddonfield (183).

Geographic distribution.—New Jersey, Alabama.

Family SIPHONODENTALIIDAE.

Genus CADULUS Philippi.

Cadulus obnutus (Conrad).

Plate LXXV., Figs. 3–4.

1869. *Gadus obnutus* Con., Am. Jour. Conch., vol. 5, p. 101, pl. 9, fig. 18.
1905. *Cadulus obrutus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 18.

Description.—Shell small, the length of an average specimen being 4 mm., and its maximum diameter 1 mm.; slightly arcuate, contracted at each end, somewhat inflated in the central region. Surface smooth.

Remarks.—This shell is so small that it is easily overlooked. In the Lorillard locality it is preserved in the form of internal casts, but at Haddonfield, the locality from which it was originally described, the shell itself is preserved.

Formation and locality.—Woodbury clay, Lorillard (102), near Haddonfield (183).

Geographic distribution.—New Jersey.

Class GASTROPODA.

Sub-Class STREPTONEURA.

Order ASPIDOBRANCHIA.

Sub-order DOCOGLOSSA.

Family PATELLIDAE.

Genus PATELLA Linneus.

Patella tentorium Morton.

Plate LXXV., Figs. 5–6.

1834. *Patella tentorium* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 50, pl. 1, fig. 11.

1841. *Hipponyx tentorium* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 8, p. 210.

1850. *Helcion tentorium* D'Orb., Prod. de Paleont., vol. 2, p. 232.

1861. *Helcion tentorium* Gabb, Synop. Moll. Cret. Form., p. 113 (57).

1864. *Helcion* (?) *tentorium* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 17.

1868. *Halcyon* ? *tentorium* Con., Cook's Geol. N. J., p. 728.

1892. *Helcion* ? *tentorium* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 153, pl. 19, figs. 6-8.

1905. *Patella tentorium* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 19.

Description.—"Shell small, orbicular or subcircular in outline, being slightly longer than wide, and measuring about half an inch in length; very depressed conical with a slightly anterior but nearly subcentral apex which is elevated above the margin equal to about one-third the length of the shell; sides and anterior end of the shell slightly concave between the apex and margin, and slightly convex along the posterior side. Surface marked by elevated, rounded, radiating costæ, which are rather wider than the interspaces and gradually increasing in size toward the margin of the shell, but are constantly increased in number, both by bifurcation and by implantation. The radii are crossed by very fine concentric lines, but toward the margin of the shell these increase in strength so as to become distinct crenulations on the top of the radii, and are nearly or quite one-half as strong as the radii themselves." (Whitfield.)

Remarks.—This shell has much the aspect of one of the inarticulate brachiopods, such as *Discina,* and according to Whitfield the shell substance seems to be phosphatic, which would seem further to suggest its brachiopod affinities. If it is one of the gastropods, it belongs to the *Patellidae,* and would seem to belong in the genus *Patella,* where it was originally placed by Morton, rather than in the genus *Helcion,* where it has usually been placed by later authors. The shell agrees with *Patella* in having a nearly central axis, instead of a marginal one, as in *Helcion.*

Formation and locality.—Navesink marl, near Arneytown (Morton).

Geographic distribution.—New Jersey.

Sub-order RHIPIDOGLOSSA.

Family PLEUROTOMARIIDAE.

Genus PLEUROTOMARIA Defrance.

Pleurotomaria crotaloides (Morton).

Plate LXXV., Figs. 7–9.

1834. *Cirrus crotaloides* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 49, pl. 19, fig. 5.
1861. *Pleurotomaria crotaloides* Gabb, Synop. Moll. Cret. Form., p. 125 (69).
1861. *Architectonica Abbottii* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 321. (In part.)
1864. *Pleurotomaria* (?) *crotaloides* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 18.
1864. *Margaritella Abbotti* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 18.
1868. *Margaritella Abbottii* Con., Cook's Geol. N. J., p. 728.
1892. *Margaritella Abbotti* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 134, pl. 17, figs. 12-15.
1896. *Pleurotomaria crotaloides* Pils., Proc. Acad. Nat. Sci. Phil. (1896), p. 10, pl. 1, figs. 1-3.
1905. *Pleurotomaria crotaloides* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 19.
1905. *Margaritella abbotti* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 20.

Description.—"Shell of medium size, subdiscoid with a very low, depressed-convex spire and nearly flat base; volutions four or five, rather slender, coiled one below the other, their upper surfaces rounded, with deep suture line, keeled on the periphery in the cast, and very depressed convex on the lower side between the

abrupt, moderate sized umbilicus and the outer angle; margin of the umbilicus abruptly rounded and the opening less than one-third of the entire diameter of the shell at any given point; upper surface of the volutions marked by closely arranged, but distinctly marked transverse undulations, which extend from the suture outward to about one-third of the width of the volution, and appear to have been directed slightly backward in their course; surface texture of the shell composed of fine spiral lines and finer transverse lines; section of the volution narrow ovate, three-fifths as high as wide, rounded on the inner end and acute on the outer margin." (Whitfield.) The dimensions of an internal cast are: height, 18 mm.; maximum diameter, 34 mm.

Remarks.—A careful examination of all the available New Jersey specimens representing *Margaritella abboti,* including the types, with the Alabama specimens of *Pleurotomaria crotaloides,* including the type of this species also, has led to the conclusion that they all represent a common species for which Morton's prior name must be used. A single specimen has been observed from Alabama which preserves the siphonal slit. It is very deep and is situated upon the upper surface of the volution, between the suture and the periphery. The presence of this slit shows the species certainly to be a member of the *Pleurotomariidae.* One large example from Mullica Hill in the collection of the Philadelphia Academy of Science has a maximum diameter of nearly 75 mm. The species differs from *P. solariformis* from the Vincentown limesand in its much more depressed spire. Gabb included these two distinct forms under his species, but the name has been restricted by Whitfield to one of them, which is only found in the Navesink marl. The species is not a very common one, and the internal casts usually do not retain the surface markings so clearly as Whitfield has figured them, some specimens even being almost entirely smooth.

Formation and locality.—Navesink marl, near Crawfords Corner (126[7]), Mullica Hill (169[2]), Crosswicks Creek (Whitfield).

Geographic distribution.—New Jersey, Alabama, Texas.

Pleurotomaria brittoni Whitfield.

Plate LXXV., Figs. 10–12.

1892. *Pleurotomaria Brittoni* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 188, pl. 23, figs. 7–9.

Description.—"Shell below a medium size, broadly conical in form, rising from a flattened base; the apical angle being about 80°. Volutions four, or from four to five in number, slightly scaliform in character; the outer face being flattened or very slightly convex, nearly in the direction of the spire, the upper surface of any individual volution being a very little larger than the basal edge of the next above it, and very slightly rounded on the angle; suture lines distinct in the casts. Base flattened or scarcely convex for two-thirds the width from the outer edge, which is moderately sharp, and then rapidly rounding into the moderately sized umbilicus. Aperture obliquely quadrangular, the inner basal or umbilical angle rounded. Slit of the outer lip not definitely ascertained in any of the specimens, which are all internal casts, but as nearly as can be ascertained has been narrow and placed at the outer basal angle, and not extending backward for more than one-third of the outer volution. Surface features unknown." (Whitfield.)

Remarks.—Except in size, and in its proportionally more highly conical form, the type specimen of this species resembles *Pleurotrema solariformis* from the Vincentown sand, the apertural slit, however, is continuous and is placed at the lower angle of the volution, instead of being composed of a series of oval perforations at the mid-height of the volution.

Formation and locality.—Manasquan marl, Farmingdale (Whitfield).

Geographic distribution.—New Jersey.

Genus PLEUROTREMA Whitfield.

Pleurotrema solariformis Whitfield.

Plate LXXV., Figs. 13–14.

1861. *Architectonica Abbotti* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 321. (In part.)

1892. *Pleurotrema solariformis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 180, pl. 22, figs. 10–14.

Description.—"Shell of more than moderate size, the largest example before me measuring almost 2¼ inches in its greatest diameter, by 1⅛ inches in height, and is an internal cast with the apical volutions absent. Volutions as preserved in this specimen, four in number, and probably one and a half or two absent; spire low, conical, the sides forming an angle of about 90°, and the volutions flattened on their upper surfaces in a line with the apical angle; sutures well marked but not deep, indicating a shell of only moderate thickness; base of the volutions flattened-convex, leaving the peripheral angle somewhat acutely rounded; the inner part of the base of the volution rapidly slopes into the broad, open perspective umbilicus, forming a rounded funnel-shaped cavity in which all the volutions are seen, but with a very slightly marked suture line separating them. Section of the volution rhombically elongate-ovate, the umbilical part being attenuated where it joins the preceding volution; along the middle of the outer volution there occurs an elevated ridge, which presents the appearance of a series of interrupted nodes of an elongate-oval shape, as if the shell had been provided with a line of oval openings occupying this position, but filling up beyond the outer half of the volution; surface of the shell unknown." (Whitfield.)

Remarks.—Members of this species were originally included by Gabb in his *Architectonica abbotti,* now referred to *Pleurotomaria crotaloides,* the types of which are from the Navesink marl at Mullica Hill. Whitfield separated the Timber Creek specimens as a distinct species, and established the new genus *Pleurotrema* for its reception.

Formation and locality.—Vincentown limesand, Timber Creek (Whitfield).

Geographic distribution.—New Jersey.

Family DEPHINULIDAE.

Genus DELPHINULA Lamark.

Delphinula navesinkensis n. sp.

Plate LXXV., Figs. 18–19.

Description.—The dimensions of the type specimen are: height, 10 mm.; maximum diameter, 15 mm. The shell has a low spire, with about two full volutions shown in the internal cast, with the suture well defined and with a broad, open umbilical cavity. The first volution increases rather rapidly in size but the enlargement of the outer volution is very gradual, its outer portion appearing, from the cast, to be free for a short distance. In the inner portion of the shell the exposed surface of the volutions is rounded, but in the outer volution, especially towards the aperture, a strong revolving angle is developed a little above the mid-height of the volution.

Remarks.—A single nearly perfect internal cast of this species has been observed, and from the cast alone its generic position cannot be determined with entire satisfaction. It is evidently a low-spired form with a broad umbilicus and without columellar folds.

Formation and locality.—Navesink marl, near Walnford (149).

Geographic distribution.—New Jersey.

Family TROCHIDAE.

Genus MARGARITA Leach.

Margarita abyssina (Gabb).

Plate LXXV., Figs. 20–22.

1860. *Solarium abyssinus* Gabb, Proc. Acad. Nat. Sci. Phil. (1860), p. 94, pl. 2, fig. 9.

1861. *Architectonica abyssinis* Gabb, Synop. Moll. Cret. Form., p. 95 (39).

1864. *Margarita abyssinus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 18.

1868. *Margarita abyssina* Con., Cook's Geol. N. J., p. 728.
1892. *Margarita abyssina* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 133, pl. 17, figs. 1-5.
1905. *Margarita abyssina* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 20.

Description.—"Shell small, not exceeding half an inch in its greatest diameter; spire moderately elevated, the apical angle being about 70° or 75°; volutions four to four and a half, very ventricose, giving a circular section when broken across; suture deep and well marked, while the whorls in the internal cast are closely appressed and slightly imbedded into each other, showing the shell to be thin; also seen where the cast rests partially in the matrix, the space left by the removal of the shell where no compression has occurred being barely perceptible; umbilicus broad and open, showing several of the volutions within; surface marked by very fine, even, spiral lines over the entire shell, with an apparent stronger line on the periphery, and crossed by finer lines of growth which are bent backward in crossing the volution, cancellating the surface." (Whitfield.)

The dimensions of a rather large individual are: height, 9 mm.; maximum diameter, 10 mm.

Remarks.—In the recent collections this species has been observed from both the Merchantville and the Navesink formations. The internal casts from the two horizons seem to be identical, except that the Navesink individuals attain a somewhat larger average size. The surface markings have been observed only on the Merchantville specimens. It is not possible to determine from Gabb's description from which horizon his type specimens were obtained, the only locality given by him being Burlington County.

Formation and locality.—Merchantville clay-marl, Lenola (163); Woodbury clay, Crosswicks (168); Navesink marl, Middletown (113^2), near Crawfords Corner (126^7), near Freehold (133), near Walnford (148^2), Crosswicks Creek (149, 147^3, 147^4, 195), near Jacobstown (150); Tinton beds, Tinton Falls (110).

Order CTENOBRANCHIATA.

Sub-order PLATYPODA.

Super-family GYMNOGLOSSA.

Family EULIMIDAE.

Genus LEIOSTRACA H. and A. Adams.

Leiostraca cretacea (Conrad).

Plate LXXV., Figs. 15–17.

1869. *Eulima cretacea* Con., Am. Jour. Conch., vol. 5, p. 100, pl. 9, fig. 15.

1892. *Leiostreca cretacea* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 150, pl. 19, figs. 2-5.

1905. *Eulima cretacea* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 20.

Description.—"Shell small, slender, subulate, spire very much elevated, smooth and polished; volutions nine or more (eleven, Conrad), flattened between the sutures, the upper edge of any volution slightly smaller than the lower edge of the one immediately above it, making the sutures remarkably distinct for a shell of this group; body volution rounded subangular in the lower part and rather rapidly contracted below to the short columella; aperture ovate-elliptical, acute above and rounded below; outer lip thin and sharp, inner lip smooth, without callus or ridges; surface polished, entirely destitute of lines or other markings. On one individual, on which the lip is broken away for one-third of the volution, there occurs a distinct spiral ridge above the columella proper and just below the junction of the outer lip with the body of the volution, within the aperture." (Whitfield.)

The dimensions of one of the type specimens are: height, 5.6 mm.; greatest diameter, 1.6 mm.; apical angle, 16°.

Remarks.—This species is known only from the specimens collected near Haddonfield many years ago.

Formation and locality.—Woodbury clay, near Haddonfield (183).

Geographic distribution.—New Jersey.

Family PYRAMIDELLIDAE.

Genus OBELISCUS Humphrey.

Obeliscus conellus Whitfield.

Plate LXXVI., Fig. 1.

1892. *Obeliscus conellus* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 151, pl. 19, fig. 1.

1905. *Pyramidella conellus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 20.

Description.—"Shell minute, the extreme length of the only specimen known being only about one-sixth of an inch. Apical angle 38° or 40°, giving a sharply conical spire; volutions five in number, very slightly scaliform, with channeled sutures, but with the surface of the volution flattened in the direction of the spire; apex apparently rounded; body volution subangular at the line of contact with the lip; aperture acute-ovate, sharp at the upper margin, and possibly pointed below (the specimen is imperfect at the base); columella slender, rounded, slightly prolonged; marked by a proportionally very strong, tooth-like ridge just below the swell of the volution; outer lip of the aperture sharp; axis imperforate; surface smooth, but not polished on the specimen, though the dullness present may be the effect of solution." (Whitfield.)

Remarks.—This species is known from a single specimen less than 5 mm. in height, which is possibly an immature shell.

Formation and locality.—Woodbury clay, near Haddonfield (183).

Geographic distribution.—New Jersey.

Super-family PTENOGLOSSA.

Family SCALIDAE.

Genus SCALA Humphrey.

Scala sillmani (Morton).

Plate LXXVI., Figs. 2–3.

1834. *Scalaria Sillmani* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 47, pl. 13, fig. 9.

1861. *Scala Sillmani* Gabb, Synop. Moll. Cret, Form., p. 135 (79).

1864. *Scala Sillmani* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 20.

1892. *Scalaria Sillmani* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 138, pl. 18, fig. 2.

1905. *Scala sillmani* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 20.

Description.—"Shell of medium size, measuring nearly one inch in length and rapidly tapering, the apical angle being about 30° or 35°; volutions five or more, very round and full, but closely compacted; the suture line deep and sharp, but close; aperture (as shown on the only specimen in hand, which is a matrix containing the shell of one side of the specimen in place and from which a gutta-percha cast is taken for description and figure), is round, but the margin is not preserved; surface of the shell marked by oblique varices, which have a slightly backward direction in crossing from the upper to the lower side of the volution; the varices are thin and recurved, and number eight on one-half of the circumference of the last volution, but decrease somewhat in number toward the apex of the spire; axis imperforate, the base of the last volution bordered by a raised carina, below which the varices do not appear to extend. So far as can be ascertained from the specimen, I should judge that the varices were slightly produced in the upper part to form subspines around the base of the preceding volution. The minute surface character of the shell can not be ascertained from the specimen in use, as only the inside of the substance is revealed, but Dr. Morton describes it as marked by 'very minute spiral striæ,' which one would suppose would naturally be the case. Mr. Gabb also speaks of it having 'much finer' revolving striæ than his *Scala (Opalia) Thomasi,* which is also a New Jersey species, and says that 'each rib is reflected back into a little lip or notch at the angle of the basal varina.'" (Whitfield.)

The dimensions of a large specimen are: height, 31 mm.; maximum diameter, 18 mm.

Remarks.—This is the species of *Scala* which has been most commonly met with in the recent collections of the Survey, but it is always a rare shell. The specimens are either internal casts, or the shell substance is very imperfectly preserved, the vertical folds of the shell usually adhering closely to the matrix.

Formation and locality.—Merchantville clay-marl, Lenola (163); Marshalltown clay-marl, near Swedesboro (177); Wenonah sand, near Crawfords Corner (126[3]), near Marlboro (130); Navesink marl, near Crawfords Corner (126[7]); Red Bank sand, Red Bank (116); Tinton beds, near Freehold (132).

Geographic distribution.—New Jersey, Alabama.

Scala thomasi Gabb ?

Plate LXXVI., Fig. 4.

1876. *Scala (Opalia) Thomasi* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 296.

1892. *Scalaria (Opalia) Thomasi* ? Whitf., Pal. N. J., vol. 2 Monog. U. S. G. S., vol. 18), p. 137, pl. 18, fig. 1.

1905. *Scala thomasi* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 20.

Description.—"Shell slender, turreted, whorls numerous, closely coiled and very ventricose, with rather close sutures, numbering seven or more in a specimen of less than seven-eighths of an inch in length; apical angle less than 30°, probably not more than 25°, the specimen being too imperfect to allow of positive measurement; aperture apparently round and the base of the volution slightly carinate, and the axis imperforate; surface marked by numerous slender, longitudinal ribs or varices, which are erect, closely arranged, and directed obliquely backward in passing from the upper to the lower side of the volutions; minute surface structure not visible on the specimen in hand." (Whitfield.)

Remarks.—This species has not been met with in the recent collections of the Survey, and the original reference of the species is too indefinite to allow its proper geologic horizon to be cor-

rectly determined; neither are the lithologic characters sufficiently clear to determine its horizon with certainty, although it apparently came from one of the marl beds.

Formation and locality.—Unknown.

Geographic distribution.—New Jersey.

Scala ? hercules (Whitfield).

Plate LXXVI., Fig. 8.

1892. *Scalaria hercules* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 140, pl. 18, fig. 12.

Description.—"Shell of large size, robust in proportions, number of volutions unknown but compact, comparatively short, not very ventricose and closely united at the suture lines; apical angle 20° to 25°, giving a rather elongated spire; volutions crossed by from 12 to 14 very strong vertical varices, which form thick rounded ribs, rather closely arranged, and each marked by two rounded tubercles, one just below the upper suture line and the other near the lower suture line; also a central line of smaller ridge-like nodes intermediate between the other two, apparent on the last volution, marking the position of a spiral carina on the center of the volution, while other spiral carinæ cross the upper and lower lines of nodes, and on the base of the last volution the usual carina surrounding the umbilicus is also marked by a thickening of the vertical ribs, but without forming distinct ribs; form of aperture and intermediate surface structure undetermined." (Whitfield.)

Remarks.—This species has not been met with in the recent collections, and the original specimens used by Whitfield are very incomplete. The species is a large one and the larger specimen used by Whitfield must have been 100 mm. or more in height and 30 mm. or more in maximum diameter. The vertical ribs upon the volutions of this species are somewhat different than is usual in the genus, they being rounded, thickened ribs and not simply varical lips, the varix having been filled to a solid rib before the growth of the shell had progressed beyond it. The number of varices varies somewhat in the different volutions. The finer markings of the shell are not well preserved in the

specimens, but on one specimen they seem to consist of closely-arranged spiral lines. The generic relations of the species have not been satisfactorily determined.

Formation and locality.—? Cliffwood clay, Cliffwood Point (Whitfield).

Geographic distribution.—New Jersey.

Genus Cavoscala Whitfield.

Cavoscala annulata (Morton).

Plate LXXVI., Figs. 5–7.

1834. *Scalaria annulata* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 47, pl. 3, fig. 10.
1861. *Scala annulata* Gabb, Synop. Moll. Cret. Form., p. 135 (79).
1864. *Scala annulata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 20.
1868. *Scala annulata* Con., Cook's Geol. N. J., p. 729.
1876. *Scala* (*Opalia*) *annulata* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 298.
1892. *Cavoscala annulata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 177, pl. 22, figs. 1–5.
1905. *Scala annulata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 20.

Description.—"Shell above a medium size for shells of this group, the largest individual, if perfect at the apex, would measure fully 1⅝ inches in length, with the aperture probably yet imperfect. Volutions about seven in number in the largest specimen, very ventricose and very slightly angular in the middle, closely coiled or in close contact; sutures deeply marked and characterized by a slightly beaded band at the bottom, formed by the edge of a broad, flattened, raised, or thickened space, which marks the base of the volutions and borders the umbilicus. Umbilicus very large, angular on the margin and rapidly sloping within, showing the preceding volutions in the cavity. Aper-

ture broadly ovate or subcircular, the inner margin straightened somewhat, conforming to the slope of the umbilicus. Surface of the shell marked by a series of moderately close, elevated, lamellose, transverse ridges or varices, which are directed rather strongly backward in their passage from above to the lower margin, and are less conspicuous on the flattened space bordering the umbilicus, within the umbilicus they are faintly shown. There are also fine transverse rigid lines parallel to the varices, occupying the ridges and intervening spaces, also rather strong, rounded, wiry spiral lines covering the entire surface of the shell, which are perceptibly directed upward in crossing the varices. This gives the surface of the shell a very beautifully cancellated structure, easily perceptible to the unaided eye." (Whitfield.)

Remarks.—This species has not been met with in the recent collections of the Survey. Whitfield described the genus *Cavoscala* with this species as the type and only representative, it being characterized especially by the wide umbilicus and the carinated suture with the under side of the outer volution flat and smooth, the smooth area being bounded by the margin of the umbilicus within and the sutural carina without.

Formation and locality.—Vincentown limesand, Timber Creek (Whitfield).

Geographic distribution.—New Jersey.

Super-family TAENIOGLOSSA.

Family NATICIDAE.

Genus LUNATIA Gray.

Lunatia halli Gabb.

Plate LXXVI., Figs. 9–19.

1860. *Lunatia Halli* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 391, pl. 68, fig. 11.

1864. *Lunatia Halli* Meek, Check List Inv. Foss N. A., Cret. and Jur., p. 20.

1868. *Lunatia Halli* Con., Cook's Geol. N. J., p. 729.

1892. *Gyrodes altispira* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 128, pl. 16, figs. 7-8.
1892. *Lunatia Halli* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 130, pl. 15, figs. 13-16.
1905. *Lunatia halli* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

Compare:

1856. *Natica obliquata* H. & M., Mem. Am. Acad. Arts and Sci., n. ser., vol. 5, p. 389, pl. 3, figs. 1 a-b.
1856. *Natica concinna* H. & M., Mem. Am. Acad. Arts and Sci., n. ser., vol. 5, p. 389, pl. 3, figs. 2 a-d.
1856. *Natica Moreauensis* M. & H., Proc. Acad. Nat. Sci. Phil. (1856), p. 282.
1858. *Natica* (*Lunatia*) *rectilabrum* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 334, pl. 35, fig. 28.
1860. *Natica acutispira* Shum., Trans. St. Louis Acad. Sci., vol. 1, p. 597.
1861. *Lunatia Moreauensis* Gabb, Synop. Moll. Cret. Form., p. 114 (58).
1861. *Natica concinna* Gabb, Synop. Moll. Cret. Form., p. 116 (60).
1861. *Natica obliquata* Gabb, Synop. Moll. Cret. Form., p. 117 (61).
1864. *Lunatia concinna* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 20.
1864. *Lunatia moreauensis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1864. *Lunatia obliquata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1876. *Lunatia concinna* Meek, Inv. Cret. and Ter. Foss. Up. Mo., p. 314, pl. 32, figs. 11 a-c.
1876. *Lunatia obliquata* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 296.

Description.—"Shell of moderate size, with an elevated spire composed of about four or four and a half volutions in entire specimen, and much resembling a *Paludina* in general appearance;

elevation about once and a half as great as the diameter of the last volution, and the last volution when measured on the apertural side forms about three-fourths of the entire height; volutions convex, not inflated, but regularly rounded, with a well marked suture in the casts, the only condition in which they are known from New Jersey, but which does not indicate a flattening at the top in the perfect shell; aperture elongate-ovate, acutely rounded below and somewhat sharper above than below, the greatest breadth being below the middle; base of the last volution sharply rounding into the umbilical cavity; umbilical opening in the cast small, not extending above the lowest volution, and showing no evidence of any thickening or callus of any kind; surface unknown." (Whitfield.)

Remarks.—This species is a common one in the faunas of the Navesink marl, where it usually occurs in the form of internal casts. These casts are certainly identical with similar specimens from Alabama, and with Mississippi specimens which retain the shell. These southern examples, however, have never been identified with the New Jersey species, but have usually been referred to *L. rectilabrum* Con., or *L. obliquata* H. &. M. Gabb has discussed the relations of these two species,[1] and considers them to be identical, but he makes no mention of *L. halli* in that connection. It is not improbable that all these shells belong to a common species, which ranges from New Jersey to the Gulf border, and then into the northwestern interior region, in which case the name *L. obliquata* would take precedence and all the other names be dropped as synonyms.

Some examples of the casts of this species apparently have a distinctly flattened band on the upper side of the volutions adjacent to the suture, and it is apparently such specimens as this that Whitfield has incorrectly referred to *Gyrodes altispira;* among a large number of casts from Mullica Hill, however, all gradations between specimens with such a flattened border and those which are rounded may be selected, and all are apparently members of a single species.

[1] Proc. Acad. Nat. Sci. Phil. (1876), p. 296.

The specimens from the Vincentown limesand which Whitfield has referred to *L. halli* are too imperfectly preserved to allow of certain identification, but they are probably distinct from the Navesink examples.

Formation and locality.—Merchantville clay-marl, Lenola (163); Wenonah sand, near Crawfords Corner (126[3]), near Marlboro (130[1]); Navesink marl, Atlantic Highlands (108), Middletown (113[2]), near Red Bank (120), near Crawfords Corner (126[7]), near Holmdel (128[5]), near Freehold (133), near Walnford (148[2]), Crosswicks Creek (149, 147[3], 147[4], 195), near Jacobstown (150), near Mount Laurel (166), Mullica Hill (169[2]).

Geographic distribution.—New Jersey, Alabama, Mississippi.

Lunatia ? pauperata (Whitfield).

Plate LXXVI., Figs. 20–23.

1892. *Scalaria ? pauperata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 141, pl. 18, figs. 3-7.

Description.—Shell of medium size, the dimensions of the larger of the two type specimens being: height, 24 mm.; maximum diameter, 19 mm.; height of aperture, 14.2 mm.; width of aperture, 10 mm. Volutions rounded, about four in number, separated in the casts by distinct and deeply marked sutures; spire elevated, the apical angle 70°-80°, the last volution forming one-half or more than one-half the entire height of the shell. Aperture subovate, rounded below, slightly more pointed above, the inner margin straighter than the outer. External surface characters of the shell not known.

Remarks.—Whitfield has included two distinct forms among the types of this species, the specimen imperfectly showing the surface characters being quite distinct from the one which is entirely a cast. Neither of the shells can be referred to the genus *Scala*. The cast, represented by Whitfield's figures 5 and 6, is taken as the type of the species *pauperata*, as the original description was largely made from that specimen, but it is here

referred to the genus *Lunatia* instead of *Scala* although the generic reference cannot be assured from the cast alone. The species differs from other members of the genus *Lunatia* in the New Jersey faunas, in the much broader columellar cavity in the casts. The specimen which partially preserves the shell differs from the other in being somewhat canaliculate in front, but the length of the canal cannot be determined, and the columella bears a single, strong, revolving rib, shown as a groove in the cast, and the shell is undoubtedly one of the *Faciolaridae* or *Volutidae*. Whitfield's illustration of the surface characters is much overdrawn.

Formation and locality.—Navesink marl, Crosswicks Creek (Whitfield).

Geographic distribution.—New Jersey.

Genus Amauropsis Mörch.

Amauropsis meekana Whitfield.

Plate LXXVII, Figs. 1–3.

1876. *Amauropsis paludinæformis* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 296. (Not *A. paludinaeformis* M. & H.)

1892. *Amauropsis Meekana* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 131, pl. 16, figs. 22-25.

1905. *Amauropsis meekana* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

Description.—"Shell of medium size, elongate-subovate; spire moderately elevated, only about two-thirds as high above the aperture as the length of the aperture; volutions five or five and a half in the largest specimen; ventricose, with distinct, well marked sutures, which are very slightly channeled; body volution more distinctly ventricose than the others; axis solid; aperture ovate, acute at the upper end, rounded and slightly effuse below; outer lip thin and sharp; columella somewhat thickened by the deposit of the lip, and grooved below the margin of

the deposit, but not umbilicate; surface of the shell marked by proportionately strong, transverse lines of growth, which are exceedingly irregular; and also by fine, even, corrugated spiral lines crossing them." (Whitfield.)

The dimensions of one of the type specimens are: height, 24 mm.; maximum diameter, 14.5 mm.; height of aperture, 14.5 mm. The largest individual observed has a height of 27 mm., and many specimens are much smaller than the dimensions of the type given.

Remarks.—This species is a close ally of the western *A. paludinaeformis,* with which it has sometimes been identified, but it is a more robust shell with shorter spire and proportionally larger body volution, which gives it a larger aperture. The surface characters of the two species are almost identical, but the New Jersey shell has the revolving lines a little more closely arranged.

Formation and locality.—Merchantville clay-marl, near Matawan (101); Woodbury clay, Lorillard (102), near Matawan (103), near Haddonfield (164, 183).

Geographic distribution.—New Jersey.

Amauropsis punctata (Gabb).

Plate LXXVII., Figs. 4-6.

1860. *Phasianella punctata* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 299, pl. 48, fig. 3.
1861. *Phasianella punctata* Gabb, Synop. Moll. Cret. Form., p. 123 (67).
1864. *Eutropia* (?) *punctata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 18.
1868. *Eutropia punctata* Con., Cook's Geol. N. J., p. 729.
1868. *Littorina punctata* Con., Cook's Geol. N. J., p. 729.
1892. *Amauropsis punctata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 132, pl. 16, figs. 17-21.
1905. *Amauropsis punctata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

Description.—"Shell small or of medium size, with an elevated spire which has an apical angle of from 40° to 45°; volutions four to five in number, very ventricose, with deep, well marked sutures, which are slightly channeled on some of the specimens; aperture round ovate, slightly pointed above and rounded below; rather less than half the length of the shell in casts or partially exfoliated individuals; columella slender and solid, and in the cast showing only a slight perforation from the removal of the substance of the axis; surface of the shell marked by fine impressed spiral lines of punctations on the type specimen, but on casts or partially exfoliated individuals this feature is not visible." (Whitfield.)

Remarks.—The generic reference of this species is by no means certain. Four specimens, including the type, are so labeled in the collection of the Philadelphia Academy of Science, all of which are from Mullica Hill, and all have the aperture incomplete. The species somewhat resembles *Lunatia halli,* but it has a more acute apical angle. The umbilical margin is rounded, as in the casts of *Lunatia halli,* and the species should possibly be referred to that genus. On the type specimen the shell is partially preserved, but the characteristic surface marking can be seen at present only upon an area about 1 mm. wide by 3 mm. long.

Formation and locality.—Navesink marl, Mullica Hill (169).

Geographic distribution.—New Jersey.

Genus GYRODES Conrad.

Gyrodes abyssina (Morton).

Plate LXXVII., Figs. 7–9.

1834. *Natica abyssina* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 49, pl. 13, fig. 13.

1861. *Gyrodes abyssina* Gabb, Synop. Moll. Cret. Form., p. 115 (59).

1861. *Gyrodes Abbotti* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 320.

1864. *Gyrodes Abbotti* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.

1868. *Gyrodes Abbottii* Con., Cook's Geol. N. J., p. 729.
1876. *Gyrodes abyssinis* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 295.
1892. *Natica abyssina* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 123, pl. 15, figs. 9-12.
1892. *Gyrodes Abbottii* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 124, pl. 15, fig. 17.
1905. *Natica abyssina* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.
1905. *Gyrodes abbottii* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

Description.—"Shell large, globose, with a flattened spire, the inner volutions of which scarcely rise above the outer ones, and are only two and a half to three in number; volutions rather ventricose and erect, ovate in a transverse section; umbilicus large and open to near the apex of the shell; aperture ovate, two-thirds as wide as long, and a little more convex on the outside than on the inner margin, nearly equally rounded above and below; suture well marked and deeply impressed." (Whitfield.) The dimensions of a large individual are: height, 57 mm.; greatest diameter, 63 mm.; height of aperture, 45 mm.; width of aperture, 36 mm.

Remarks.—This species strongly resembles *Gyrodes crenata* in general form, but, as the two species occur in New Jersey, it is usually larger than that species. The casts of the two species can be easily distinguished, however, by the contour of the lower side of the volutions on the edge of the wide umbilicus, this portion of the shell in *N. abyssina* being rounded, while in *G. crenata* it is more or less angular or subcarinate. In the recent collections of the Survey the two species have been observed, in general, to be characteristic of different geologic horizons, *N. abyssina* usually being a Navesink species, while *G. crenata* has not been observed in that formation, being most commonly found in the Merchantville clay-marl. In the collections of the National Museum at Washington this species occurs abundantly from Texas, with the shell more or less perfectly preserved. These specimens show that the suture is canaliculate, the groove being narrow and of moderate depth, with a sharp, subcarinate margin.

The umbilical shoulder is rounded, but just below the umbilical margin, upon the slope into the umbilicus, the surface is abruptly impressed, the outer thickened rim so formed being transversely wrinkled or crenate. The single example described by Gabb as *G. abbotti* is certainly not of specific value, and that species must be considered as a synonym of *G. abyssina*. The specimen from the Vincentown formation at Timber Creek, which has been identified as *Natica abyssina* by Whitfield, is doubtless a distinct species, although the single specimen, an imperfect internal cast, is not sufficient to show its specific characters fully.

Formation and locality.—Navesink marl, Atlantic Highlands (108), near Crawfords Corner (126^7), Crosswicks Creek (147^4), Mullica Hill (169^2).

Geographic distribution.—New Jersey, Alabama, Texas.

Gyrodes crenata Conrad.

Plate LXXVII., Figs. 10–12.

1860. *Natica (Gyrodes) crenata* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 289.
1861. *Gyrodes crenata* Gabb, Synop. Moll. Cret. Form., p. 116 (60).
1861. *Natica infracarinata* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 319.
1861. *Gyrodes Spillmani* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 320.
1864. *Gyrodes crenata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1864. *Gyrodes Spillmani* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Gyrodes infracarinata* Con., Cook's Geol. N. J., p. 729.
1892. *Gyrodes infracarinta* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 125_2, pl. 15, figs. 13–16.
1892. *Gyrodes crenata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 126, pl. 16, figs. 5–6.
1905. *Gyrodes crenata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

1905. *Gyrodes crenata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

1905. *Gyrodes spillmani* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

Description.—Shell of medium size, the dimensions of a rather large internal cast being: maximum width, 30 mm., height, 23 mm.; height of aperture, 20 mm.; width of aperture, 13.5. Depressed globular above with a depressed spire, broadly umbilicate below. Volutions about four in number, the outer one of which forms fully two-thirds of the bulk of the entire shell, largest below the middle, the casts slightly flattened on top adjacent to the suture, strongly angular on the base bordering the umbilicus. Aperture large, oblique, widest below the middle. In specimens preserving the shell, or in impressions of the exterior, a distinct band of elevated crenulations or transverse nodes marks the top of the volutions just below the suture, and forms a decided ridge around the spiral portion of the shell. Surface of the shell marked by fine lines of growth parallel with the margin of the aperture, and passing over the line of nodes on the upper surface of the volution.

Remarks.—Casts of this species in the Merchantville clay-marl are sometimes modified by the compression of the matrix so as to preserve most of the external features of the shell. The upper portion of the volutions is distinctly flattened so as to form a distinct revolving angulation at a little distance from the suture, but the crenulations are not often seen on these modified casts. The shell surface is marked by distinct transverse lines of growth, which are directed rather strongly backward below the revolving angulation, so that the outer lip of the aperture is strongly oblique in lateral view. The casts resemble those of *Gyrodes abyssina,* but in the New Jersey collections they are always smaller than the larger individuals of that species, and they may be distinguished by the angular or subcarinate margin of the broad umbilicus, which is notable even in the casts. The two species also have a different geologic range in the New Jersey beds. In the southern localities the species often grows to a larger size than any of the specimens observed in New Jersey.

An examination of numerous examples from southern localities in the collection of the National Museum at Washington has shown that *G. infracarinata* is not distinct from *G. crenata,* one species having been described from internal casts and the other from examples with the shell preserved. The type of *G. spillmani* Gabb, preserved in the collection of the Philadelphia Academy of Science, is also not distinct from *G. crenata.*

Formation and locality.—Merchantville clay-marl, near Matawan (100[4], 101), near Jamesburg (141), Lenola (163); Woodbury clay, near Haddonfield (183); Wenonah sand, near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey, Alabama, Mississippi.

Gyrodes altispira (Gabb).

Plate LXXVII., Figs. 19-21.

1861. ? *Lunatia altispira* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 320.
1861 ? *Gyrodes obtusivolva* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 320.
1864. *Lunatia* ? *altispira* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 20.
1864. *Gyrodes* ? *obtusivolva* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Lunatia altispira* Con., Cook's Geol. N. J., p. 729.
1868. *Gyrodes obtusivolva* Con., Cook's Geol. N. J., p. 729.
1869. *Lunatia obtusivolva* Con., Am. Jour. Conch., vol. 5, p. 45, pl. 1, fig. 11.
1892. *Gyrodes obtusivolva* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 129, pl. 16, figs. 9-12.
1905. *Gyrodes altispira* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.
1905. *Gyrodes obtusivolva* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

Description.—"Shell, as known from internal casts, of moderate size, somewhat erect, obliquely subglobose with a moder-

ately elevated spire, whorls three or three and a half, the outer ones flatly truncate on the top adjacent to the suture line, the truncation being strongly marked and angular at the margin. On fully grown specimens it is nearly an eighth of an inch in width on the outer half of the last volution; aperture oblique, ovate, widest below and truncated above by the flattening of the upper surface of the volution; umbilicus, as seen in the casts, small, indicating a slender, almost if not entirely solid columella; margin of the umbilical depression not angular; surface of the shell, as seen on fragments remaining attached to the casts, marked by fine tranverse lines of growth." (Whitfield.)

The dimensions of a large individual are: maximum diameter, 23 mm.; height, 20 mm.; height of aperture, 17 mm.; width of aperture, 13 mm.

Remarks.—The original type of *G. altispira* has apparently been lost or destroyed, but there are in the collection of the Philadelphia Academy of Science, several specimens labeled "duplicate types" in Gabb's own handwriting, which must be taken as authentic representatives of the species. These specimens are certainly specifically identical with the type of *G. obtusivolva,* preserved in the same collection. These two species were described at the same time by Gabb, but the species *altispira* precedes *obtusivolva,* and consequently that name takes precedence. The specimen which Whitfield has illustrated as an example of *G. altispira* is apparently only a member of the species *Lunatia halli.*

As observed in the recent collections of the Survey, this species is restricted to the Merchantville clay-marl, and, judging from their lithologic characters, the types of *G. altispira* and *G. obtusivolva* are apparently from this formation also. The species differs from the associated *G. crenata* in the much smaller umbilicus and narrower shell, in the absence of the subcarinate lower surface of the volutions, and in the absence of the conspicuous crenate band above. The species differs from *Lunatia halli* in the lower spire and in the truncate upper surface of the volutions adjacent to the suture. The species differs from *G. petrosa* in its proportionately greater height, the less spreading or patulose outer volution, the more elevated spire and the smaller umbilicus.

Formation and locality.—Merchantville clay-marl, near Matawan (101), Lenola (163).

Geographic distribution.—New Jersey.

Gyrodes petrosus (Morton).

Plate LXXVII., Figs. 13-18.

1834. *Natica petrosa* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 48, pl. 19, fig. 6.
1860. *Natica alveata* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 289, pl. 46, fig. 45.
1861. *Gyrodes petrosa* Gabb, Synop. Moll. Cret. Form., p. 117 (61).
1864. *Gyrodes alveata* Meek, Check List. Inv. Foss. N. A., Cret. and Jur., p. 21.
1864. *Gyrodes petrosa* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Gyrodes petrosus* Con., Cook's Geol., N. J., p. 729.
1876. *Gyrodes petrosa* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 295.
1892. *Gyrodes petrosus* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 127, pl. 16, figs. 1–4.
1905. *Gyrodes petrosus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

Description.—"Shell (as seen in casts) of medium size or smaller, obliquely oval or depressed and somewhat patulose, with a low spire; the entire adult shell having three to three and a half volutions, the last of which forms the greatest bulk of the shell; volutions obliquely compressed from above, largest below the middle, often slightly flattened on the supper half and with a distinct flattened space bordering the suture; aperture large, very oblique, strongly receding below as seen in profile on its edge; semilunate in outline, rounded below and slightly acute above, somewhat modified in the upper part by the intrusion of the preceding volution; umbilicus large, broadly patulose within, and apparently without callus; peristome thin, and the substance of

the shell also apparently slight; surface of the shell unknown." (Whitfield.)

The dimensions of an average-sized adult specimen are: maximum diameter, 25 mm.; height, 19 mm.; height of aperture, 23 mm.; width of aperture, 12 mm.

Remarks.—This species is the commonest member of the genus in the New Jersey faunas, and also has the greatest vertical range, although the horizon where it occurs most commonly is the Navesink marl. The species most closely resembles *G. abyssina*, but it is always smaller than adult individuals of that species, and can be distinguished by the conspicuous flattened space at the summit of the volutions, just outside the suture.

Formation and locality.—Merchantville clay-marl, near Jamesburg (139), Lenola (163); Wenonah sand, near Crawfords Corner (126^3), near Marlboro (130); Navesink marl, Atlantic Highlands (108), Middletown (113^2), near Crawfords Corner (126^7), near Holmdel (128^3), near Walnford (148^2), Crosswicks Creek (149, 147^4, 195), near Jacobstown (150), Mullica Hill (169^2); Red Bank sand, Red Bank (116), near Middletown (112).

Geographic distribution.—New Jersey, Alabama, Mississippi, Texas.

Family XENOPHORIDAE.

Genus XENOPHORA Fischer.

Xenophora leprosa (Morton).

Plate LXVIII., Fig. 1–3.

1834. *Trochus leprosus* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 46, pl. 15, fig. 6.

1861. *Phorus leprosus* Gabb, Synop. Moll. Cret. Form., p. 124 (85).

1864. *Phorus leprosus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 18.

1868. *Onustus leprosus* Con., Cook's Geol. N. J., p. 728.

1892. *Xenophora leprosa* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 135, pl. 17, figs. 16–19.

1905. *Xenophora leprosa* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

Description.—"Shell small or below a medium size, trochiform, or broad conical; the spire having an apical angle of less than 90°; base flat or concave, usually more or less depressed in the center, with the margin of the volution more or less rounded, and in old individuals sometimes distinctly rounded; casts showing a small umbilical perforation, but the axis probably solid in the shell; volutions probably seven or eight, but in the casts the upper ones are usually absent and seldom show more than four or four and a half; one small specimen retaining the upper whorls, to the number of four and a half, measures only five-eighths of an inch in diameter. This one, if continued below to the size of the larger one figured, would possess at least eight volutions; whorls obliquely flattened on their surfaces in the direction of the spire, with only a small portion of their edges rounded or vertical, and the surface deeply and abundantly scarred by the cicatrices of foreign substances which have been attached to the surface of the shell during life; aperture compressed, transversely ovate or trapezoidal, and the outer margin much prolonged." (Whitfield.)

The dimensions of an internal cast are: height, 28 mm.; maximum diameter, 44.5 mm.

Remarks.—This species usually occurs in a more or less fragmentary condition, and in New Jersey it appears to be characteristic of the Navesink marl. The only species with which it can be confused is *Endoptygma umbilicata*, but that is a much smaller shell restricted to the Merchantville clay-marl, and is furnished with an internal revolving ridge upon the lower side of the volution, which can always be recognized as a distinct groove in the casts.

Formation and locality.—Navesink marl, Atlantic Highlands (108), Crawfords Corner (126[7]), Crosswicks Creek (195), near Jacobstown (150).

Geographic distribution.—New Jersey, Alabama.

Genus ENDOPTYGMA Gabb.

Endoptygma umbilicata (Tuomey).

Plate LXXVIII., Figs. 4–6.

1855. *Phorus umbilicatus* Tuom, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 169.

1876. *Endoptygma umbilicata* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 302, pl. 17, figs. 8–9.

1892. *Endoptygma umbilicata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 136, pl. 17, fig. 20.

Description.—"Shell rather below a medium size, spire broadly conical, with an apical angle of about 80°, and composed of about four volutions; base flat or slightly concave, and in the cast showing a small open umbilical perforation, representing the comparatively slender solid columella; the base of the cast is marked by a rather deep, narrow, spiral groove, about one-third to one-fourth of the width of the volution from the umbilical cavity, marking the position of an internal spiral ridge at this point on the inside of the basal portion of the shell; volutions flattened in this direction of the spire, with moderately distinct suture lines separating them in the casts, their surfaces closely and deeply scarred by the attachment of foreign substances to the outside of the shell during life." (Whitfield.)

The dimensions of an average specimen are: height, about 14 mm.; maximum diameter, 19.5 mm.

Remarks.—This species often occurs abundantly in the Merchantville clay-marl, but the specimens are usually more or less fragmentary and are always internal casts. In New Jersey it has never been found associated with *Xenophora leprosa*, a species which is characteristic of the Navesink marl. It may be easily distinguished from *X. leprosa* by the revolving furrow on the lower side of the casts usually about one-third of the distance from the umbilicus to the periphery, and usually by its smaller size, although an example from Mississippi has been observed

with a diameter of nearly 50 mm. The ridge which produces this furrow in the casts seems to have increased in strength with the growth of the shell, as it is less distinct in the smaller fragments.

Formation and locality.—Merchantville clay-marl, near Matawan (101), Lenola (163), near Burlington (Whitfield).

Geographic distribution.—New Jersey, Mississippi, Alabama.

Family TURRITELLIDAE.

Genus Turritella Lamark.

Turritella vertebroides Morton.

Plate LXXVIII., Figs. 14–17.

1834. *Turritella vertebroides* Mort, Synop. Org. Rem. Cret. Gr. U. S., p. 47, pl. 3, fig. 13.
1861. *Turritella vertebroides* Gabb, Synop. Moll. Cret. Form., p. 148 (92).
1864. *Turritella vertebroides* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 19.
1868. *Turritella vertebroides* Con., Cook's Geol. N. J., p. 729.
1892. *Turritella vertebroides* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 146, pl. 18, figs. 13-18.
1905. *Turritella vertebroides* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

Description.—Shell acutely angular, the apical angle about 20°; the dimensions of a large individual from Alabama are: maximum diameter, 20 mm.; length with the apex broken, 64 mm.; number of volutions preserved, 10. Suture moderately impressed, situated a little below the center of a rounded, revolving furrow; surface of the volutions depressed convex from suture to suture. Surface marked by four or five subequal, angular, revolving costæ, with several much finer ones occupying each of the interspaces, and by fine transverse lines of growth which describe a concave curve in passing downward from the suture. In the casts the volutions are moderately close, the surface is smooth

and rounded curving rather abruptly into the sutures above and below.

Remarks.—The type of this species has the shell partially preserved, and from its lithologic character it apparently came from the Navesink marl. The species occurs commonly in the Ripley formation of the South in some localities, and many specimens are preserved in the collections of the National Museum at Washington, with the shell perfectly preserved. The foregoing description has been taken largely from southern examples and two individuals have been illustrated. In New Jersey the species occurs almost always in the form of internal casts in the Navesink marl. These casts may be recognized by their rounded volutions, being different in this respect from the similar casts of *T. encrinoides* in which the larger volutions are distinctly quadrangular in cross-section.

Formation and locality.—Navesink marl, Atlantic Highlands (108), near Crawfords Corner (126^7), Crosswicks Creek (147^4, 149, 195), near Jacobstown (150), near Mount Laurel (166).

Geographic distribution.—New Jersey, Alabama.

Turritella encrinoides Morton.

Plate LXXVII., Figs. 10–13.

1834. *Turritella encrinoides* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 47, pl. 3, fig. 7.
1861. *Turritella encrinoides* Gabb, Synop. Moll. Cret. Form., p. 146 (90).
1864. *Turritella encrinoides* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 18.
1868. *Turritella encrinoides* Con., Cook's Geol. N. J., p. 729.
1876. *Turritella encrinoides* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 301.
1892. *Turritella encrinoides* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 143, pl. 18, figs. 19-22.
1905. *Turritella encrinoides* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.
1892. *Turritella pumila* ? Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 187, pl. 23, figs. 5-6. (Not *T. pumila* Gabb.)

Description.—Shell acutely angular, the angle of divergence of the sides being about 20°. Suture not strongly impressed, situated in an angular, rounded furrow; surface of the volutions depressed convex, nearly flat in the central portion and curving more abruptly to the sutures above and below. Surface marked by three major revolving costæ which are flattened on top; in addition to the major costæ there are lower, angular, revolving ribs situated as follows, one between the lower suture and the first major costa, one between the first and second costæ, two between the second and third costæ, and two between the third major costa and the upper suture. In the casts the sutures are rather close, especially between the lower and larger volutions; the lower volutions are more or less quadrangular in cross-section, the upper ones being rounder, due undoubtedly to the internal thickening of the shell with age.

Remarks.—The type of this species is the only one observed which preserves any portion of the shell. From its lithologic characters it is apparently from the Navesink marl. The casts from this formation which are referred to the same species are somewhat common and can always be distinguished from the casts of the associated *T. vertebroides* by the quadrangular cross-section of their larger volutions. The example which Whitfield has illustrated as *T. pumila* ? from the Manasquan marl is certainly incorrectly identified; the specimen is preserved in the collection of the Philadelphia Academy of Science and, judging from its lithologic characters it came originally from the Navesink marl, and it seems to be only a somewhat abnormal example of *T. encrinoides.*

Formation and locality.—Navesink marl, Atlantic Highlands (108), Middletown (113[2]), near Crawfords Corner (126[7]), near Holmdel (128[5], 127), near Freehold (133), near Walnford (148[2]), Crosswicks Creek (149, 195), near Jacobstown (150), Mullica Hill (169[2]).

Geographic distribution.—New Jersey, Alabama.

Turritella quadrilira Johnson.

Plate LXXVIII., Fig. 7.

1898. *Turritella quadrilira* Johns., Ann. Rep. Geol. Surv. N. J. for 1897, p. 264.

1898. *Turritella quadrilira* Johns., Proc. Acad. Nat. Sci. Phil. (1898), p. 463.

1905. *Turritella quadrilira* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

Description.—Apical angle about 20°; the figured specimen is the apical portion of a shell 19.5 mm. in length, with a maximum diameter of 8 mm., showing nine volutions. Suture situated a little above the middle line of a broad, smooth, depressed, concave channel whose lower slope is less abrupt than the upper, and whose width is more than one-half the width of the elevated portion of the volutions. Surface of the volutions between the sutural depression, a little convex and marked by four strong, angular, revolving ribs, the uppermost of which is slightly smaller than the others; the interspaces between the ribs are broader than the ribs themselves, smooth and rounded in the bottom.

Remarks.—This species has a slight resemblance to *T. tricostata* from the Wenonah sand, but so far as known, it is a much smaller shell with a somewhat greater apical angle. If it should be found, however, growing to so large a size as the Wenonah species, it can be easily distinguished by its four revolving ribs and the convex surface of the volutions between the sutural depressions.

Formation and locality.—Cliffwood clay, Cliffwood Point (105), near Matawan (107); Woodbury clay, near Matawan (103), deep well at Mount Laurel (Johnson).

Geographic distribution.—New Jersey.

Turritella ? granulicosta Gabb.

Plate LXXIX., Figs. 15–17.

1861. *Turritella granulicosta* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 363.

1864. *Turritella granulicostata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 18.

1868. *Turritella granulicostata* Con., Cook's Geol. N. J., p. 729.

1892. *Turritella ? granulicostata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 144, pl. 18, figs. 10-11.

1905. *Turritella granulicosta* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

1892. *Turritella compacta* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 142, pl. 18, figs. 8-9.

1905. *Turritella compacta* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

Description.—"Shell small, with very short, slender, and closely coiled but rapidly enlarging whorls, giving a rapidly increasing diameter to the shell with increased growth. Apical angle about 15°. Volutions about eight in number in a specimen which has been not more than seven-eighths of an inch in its extreme length; flattened convex on their outer surface, and subangular at the upper and lower margins, with a nearly flat base. Lower margin of the volution proportionally larger than the upper. Suture lines between the whorls narrow, but very distinctly marked. Surface marked by about 12 fine, thread-like revolving ribs, three of which are larger than the rest, are placed at equal distances from each other, and from the upper and lower edges, and are slightly undulated so as to produce a series of minute nodes. This character shows itself to a much less extent on some of the smaller ribs. Under surface of the body volution marked by a few fine revolving ribs, with regular concavities between them." (Whitfield.)

Remarks.—The type of this species has the shell preserved on one side only, the opposite side showing the characters of the internal cast. A comparison of this specimen with that used by Whitfield as the type of his *T. compacta* shows the two to be essentially the same, so that *T. compacta* becomes a synonym. The species has not been met with in the recent collections of the Survey, so that its proper horizon cannot be certainly determined, but from the lithologic characters of the type the species apparently belongs in the Navesink fauna, although it is possibly from the Merchantville.

Formation and locality.—? Navesink marl, Burlington County (Gabb).

Geographic distribution.—New Jersey.

Turritella lippincotti Whitfield.

Plate LXXIX., Fig. 1.

1892. *Turritella Lippincotti* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 145, pl. 18, figs. 23-24.

Description.—"Shell of medium size, rather rapidly tapering, the apical angle being about 20° or less. Volutions flattened on the surface in the direction of the spire, with scarcely perceptible suture lines where the shell is preserved, and only very moderate ones in the cast; their form in a section being trapezoidal, the upper and lower outer angles being rather sharply angular, even in an internal cast; basal face scarcely convex; volutions numerous, a fragment measuring not quite 2 inches in length, with a diameter at the lower end of five-eighths of an inch, retaining seven, with space at the upper portion for about five more. Surface of the shell marked, in the only specimen which preserves it, by fine rounded spiral, thread-like lines over the entire surface." (Whitfield.)

Remarks.—Whitfield's types of this species are casts from natural moulds which show the external features of the shell. The species is characterized by the flat outer surface of the volutions, and the slightly impressed suture. Whitfield does not illustrate the casts of the species, although he mentions their characters. In the recent collections of the Survey this species has not been observed, at least not in a condition to exhibit its external markings.

Formation and locality.—Navesink marl, Crosswicks Creek, Holmdel (Whitfield).

Geographic distribution.—New Jersey.

Turritella lenolensis n. sp.

Plate LXXVIII., Fig. 8.

Description.—Apical angle about 18°. The type specimen is the apical portion of a shell 11.5 mm. in length and 4.5 mm. in maximum diameter, and retains 10 volutions. The volutions are

sharply carinate at about their mid-height, the space between the carinæ of adjacent volutions being a broad, deep, concave, revolving depression, whose upper slope is more abrupt than the lower, and whose greatest depth is a little above the middle. Suture situated near the middle of the revolving depression, a little below the line of greatest depth. The entire surface of the shell is marked with very fine, elevated, revolving lines.

Formation and locality.—This species differs from all other New Jersey Cretaceous species of the genus, which have been observed, in the strongly carinated volutions, the shell being in this respect a miniature example of *T. mortoni* var. *postmortoni* Harris, from the Eocene.[1] The species here described, however, is quite distinct from that Eocene form in other respects. The type specimen is the apical portion of a shell only, being incomplete at the opposite extremity, so that it may be found to grow much larger with a greater number of volutions.

Formation and locality.—Merchantville clay-marl, Lenola (163); Woodbury clay, near Haddonfield (183).

Geographic distribution.—New Jersey.

Turritella trilira Conrad.

Plate LXXIX., Fig. 4–5.

1860. *Turritella trilira* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 285.
1861. *Turritella Corsicana* Shum., Proc. Bost. Soc. Nat. Hist., vol. 8, p. 196.
1861. *Turritella trilira* Gabb, Synop. Moll. Cret. Form., p. 147 (91).
1864. *Turritella corsicana* Meek, Check List Inv. Foss. N. A., Cret and Jur., p. 18.
1864. *Turritella trilira* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 19.
1902. *Turritella trilineata* Hill and Vaughan, U. S. G. S., Geol. Atlas, Austin Folio, fig. 47.

[1]Eocene Rep., Md. Geol. Surv., pl. 26, fig. 5.

Description.—Shell with an apical angle of about 27°; the figured specimen 36 mm. in length, with a maximum diameter of 13.5 mm., and showing seven volutions. The specimen is incomplete at both ends, and when complete it must have been 60 mm. or more in length, with 14 or more volutions. Suture situated near the middle of a rather broad, depressed, concave channel of moderate depth, the lower slope of the channel being less abrupt than the upper and with a slight revolving rib midway of the slope; the greatest depth of the sutural furrow lies a little above the suture itself. Surface of the volutions, between the margins of the sutural furrow, flat and marked by three strong, revolving, angular ribs of equal strength, with rounded interspaces.

Remarks.—This shell has much the aspect of *T. gatunensis* Con., as illustrated by Dall[1], from the Eocene, but the three revolving ribs are more nearly equal in height, consequently making the surface of the volutions between the sutural channel appear much flatter.

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]), near Marlboro (130).

Geographic distribution.—New Jersey, Alabama, Mississippi, Texas, Arkansas.

Turritella tippana Conrad.

Plate LXXIX., Figs. 6–7.

1858. *Turritella tippana* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 333, pl. 35, fig. 19.
1861. *Turritella Tippana* Gabb, Synop. Moll. Cret. Form., p. 147 (91).
1864. *Turritella tippana* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 19.

Description.—The dimensions of a large example, incomplete at the apex, are: height, 69 mm.; greatest diameter, 22 mm.; apical angle about 19°; number of volutions shown, 10. Suture

[1] Trans. Wagner Free Inst. Sci., vol. 3, p. 310, pl. 17, fig. 10.

situated in the bottom of a broad, concave, revolving channel. Surface of the volutions between the margins of the sutural channel, nearly flat or slightly convex; marked by four or five strong, revolving costæ, the three lower ones being subequidistant, the upper one more remote; in the broader interspace between the uppermost strong costa and the one next below, is a much finer rib, and a similar one about midway on the slope from the uppermost strong costa to the suture, although this last one is sometimes strong enough, especially in the larger shells, to be counted as one of the major ribs; in each of the interspaces between the three lowermost strong costæ on the larger volutions, there is frequently a much smaller raised line; and on the slope of the lowermost one of these costæ to the lower suture, another one somewhat stronger than those in the interspaces above. The surface is also marked by very fine transverse lines of growth.

Remarks.—Conrad's original illustration of this species is very poor and from it alone the species would not be recognizable. A large number of excellent examples, however, have been examined in the collection of the National Museum at Washington, and the New Jersey specimens do not differ from them specifically. The southern specimens show considerable variation in the secondary revolving ribs, but the three strong ribs below, followed by a broader interspace and then a fourth rib is a constant character of the species. In New Jersey the species is associated with *T. marshalltownensis* but is much less common, and is represented by fragments only. The surface markings are sufficiently peculiar to render the identification of mere fragments of the shell a comparatively easy matter, but the internal casts would not be materially different from those of several other species.

The species should be compared with *T. winchelli* Shum.[1], from Texas, a species which has a similar interval between the upper costa and the three lower ones, but the shell of that species is coarser in appearance, the revolving lines broader and stronger, and in some individuals only two strong ribs are present below the interval.

[1] Bost. Soc. Nat. Hist., vol. 8, p. 196.

Formation and locality.—Marshalltown marl, near Swedesboro (177).

Geographic distribution.—New Jersey, Mississippi.

Turritella jerseyensis n. sp.

Plate LXXIX., Figs. 2–3.

Description.—The dimensions of the type specimen, a nearly complete internal cast, are: height, 38 mm.; maximum diameter, 9 mm.; apical angle about 16°; number of volutions present, 9. In the cast the sides of the shell from the apex to the largest volution are slightly convex, the divergence of the sides decreasing as the shell increases in length. The suture in the cast is close between the apical volutions, becoming broader and more open as it approaches the aperture; the surface of the volutions is smooth, flattened or slightly convex in the central portion, and curving more abruptly into the suture. Externally, as shown by a cast from the natural mould, the suture is slightly impressed in a narrow angular groove, the surface of the volutions is flat and marked by about five rather broad, low, revolving ribs, of which the lowest one is the stronger, two faint revolving ribs can also be detected near the periphery on the lower surface of the last volution.

Remarks.—This species is established upon a nearly complete internal cast, of which one or two of the small apical volutions may be missing, with fragments of the impression of the exterior of the same individual. In its flat volution and slightly impressed suture it resembles *T. lippincotti* Whitf., from the Navesink marl, but it is a smaller shell, with fewer and stronger revolving ribs. The species is more slender than any other member of the genus in the New Jersey faunas, unless it be *T. lippincotti,* and the reduction of the angle of divergence of the sides is distinctly noticeable in the casts.

Formation and locality.—Cliffwood clay, Cliffwood Point (185).

Geographic distribution.—New Jersey.

Turritella lorillardensis n. sp.

Plate LXXIX., Figs. 10–12.

Description.—The dimensions of the type specimen are: height, 52 mm.; maximum diameter, 19 mm.; angle of divergence of the sides, 27°; number of volutions shown, 10. Suture moderately impressed, situated in the bottom of an angular groove; volutions moderately convex from suture to suture, the lower half slightly more curved than the upper, and the larger volutions flatter than those towards the apex of the shell. Surface marked with fine revolving ribs, eight or nine of which are of nearly equal size and are at equal distances apart; on the lower half of each larger volution the first three or four interspaces between the primary ribs are occupied by secondary ribs, one or two of which in the last volution of large individuals, become nearly as strong as the primary ones; at the upper and lower margins of the volutions, on each of the slopes into the sutural depression, there are two or three additional, smaller, revolving ribs, those just below the suture being somewhat more conspicuous than those above. On one individual somewhat larger than the type, there are upon the last volution, from one to four additional raised, revolving lines in each of the interspaces between the larger ribs. The basal margin of the last volution is angular, and the lower side of the volution is flat and marked with about eight or ten faint, raised, revolving lines. In the internal casts the sutural cavity is narrow, indicating a thin shell, the volutions towards the apex are convex, the more mature volutions becoming more and more quadrangular in cross-section.

Remarks.—This is a common species in the Woodbury clay at Lorillard. It resembles somewhat closely the *T. merchantvillensis*, but has a less acute apical angle, and it lacks the fine, raised, revolving striæ which cover the entire surface of that species.

Formation and locality.—Woodbury clay, Lorillard (102), near Matawan (103), Crosswicks (168).

Geographic distribution.—New Jersey.

Turritella merchantvillensis n. sp.

Plate LXXIX., Fig. 13.

Description.—The dimensions of a specimen incomplete at each extremity are: height, 60 mm.; maximum diameter, 17 mm.; angle of divergence of the sides about 10°; number of volutions shown, 9. If the specimen were complete at the apical extremity, it would be 75 mm. or more in length, with about 15 volutions. Suture moderately impressed, situated in the bottom of an angular groove; the surface of the volutions moderately convex from suture to suture, the greatest diameter below the middle so that the slope of the lower half is more abrupt than that of the upper. Surface of the shell marked with 10 or 12 fine, raised, revolving costæ, one of which, near the base of the volutions, is slightly stronger than the others; between the costæ the surface is entirely covered with much finer, raised, revolving lines. The internal casts have a narrow, almost closed sutural cavity, indicating a thin shell, and they usually have a more or less indistinct, narrow, revolving band above the middle of the volutions; surface of the volutions moderately convex, sometimes tending to become more flattened in the more mature portions of the shell.

Remarks.—This is the abundant species of the Merchantville clay-marl, and usually occurs in the form of internal casts, although impressions of the exterior are frequently preserved in the matrix. The species resembles *T. lorillardensis*, but it is more slender, with a more acute angle of divergence, and the surface markings of the two species are different, the surface of *T. merchantvillensis* being entirely covered with extremely fine, raised, revolving lines between the stronger costæ.

Formation and locality.—Merchantville clay-marl, near Matawan (100[4], 101), near Jamesburg (139, 140, 141), Lenola (163), Merchantville (162).

Geographic distribution.—New Jersey.

Turritella marshalltownensis n. sp.

Plate LXXIX., Fig. 14.

Description.—The dimensions of a specimen incomplete at each extremity and slightly compressed are: height, 60 mm.; maximum diameter, about 20 mm.; angle of divergence of the sides, about 12°, number of volutions shown, 7. If the specimen were complete to the apical extremity it would be 75 mm. or more in length, with 15 or more volutions. Suture moderately impressed, situated in the bottom of a broadly angular, revolving groove; the surface of the volutions moderately convex, their greatest diameter at or a little below the mid-height. Surface marked by about 12 fine, revolving costæ, between which, in the lower half of the volution at least, there are usually alternate smaller ones. Shell substance thin.

Remarks.—This species most closely resembles *T. merchantvillensis,* but the greatest diameter of the volutions is higher than in that species, the stronger revolving costæ are slightly broader and flatter, and the entire surface is not covered by the very fine revolving lines of that species. This species occurs abundantly in the Marshalltown clay-marl near Swedesboro, with the shell substance well preserved, but the specimens are almost always somewhat compressed, doubtless because of the thinness of the shell, and they are always incomplete, neither the apex nor the perfect aperture having been observed in any specimen.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177).

Geographic distribution.—New Jersey.

Family VERMETIDAE.

Genus SILIQUARIA Bruguiere.

Siliquaria pauperata Whitfield.

Plate LXXIX., Figs. 18–20.

1892. *Siliquaria pauperata* Whitf., Pal. N. J., vol 2 (Monog. U. S. G. S., vol. 18), p. 149, pl. 18, figs. 26–28.

1905. *Siliquaria pauperata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 21.

Description.—"A few specimens only of casts of tubes referable to this genus have come under my notice. Two of them are coiled and retain the younger parts of the specimens, while most of them are only fragments representing medium sized parts of the tubes, or parts from the large irregularly coiled portions. The tube is very gradually tapering, and either compactly or loosely coiled in the upper part, but all show their relations to the genus *Siliquaria,* by the narrow ridge left along the upper side of the tube by the material which has filled the slit. There is no distinctive feature represented on the specimens by which they can be distinguished from casts of other species of the genus; and, as no evidence of the surface characters are preserved, no data for comparison is left." (Whitfield.)

Remarks.—This species has not been met with in the recent collections of the Survey, but the lithologic characters of the type indicate that their proper horizon is the Navesink marl.

Formation and locality.—Navesink marl, New Jersey (Whitfield).

Geographic distribution.—New Jersey.

Genus LAXISPIRA Gabb.

Laxispira lumbricalis Gabb.

Plate LXXXI., Figs. 1–2.

1876. *Laxispira lumbricalis* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 301.

1883. *Laxispira lumbricalis* Tryon, Struct. and System. Conch., vol. 2, p. 309, pl. 79, fig. 14.

1892. *Laxispira lumbricalis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 148, pl. 18, fig. 25.

1905. *Laxispira lumbricalis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 22.

Description.—The dimensions of a large specimen, an internal cast, are: height, 29 mm.; maximum diameter, 12.5 mm.; apical angle, about 28°; number of volutions, about 4½; height of aperture, 8.5 mm.; width of aperture, 6.3 mm. Shell forming an open spiral, in which the volutions are not in contact, the suteral space in the casts being nearly as wide as the diameter of the volutions. Cross section of the volutions nearly circular, except in the outer volution of mature shells, in which, near the aperture, the shell is slightly compressed, making the aperture higher than it is wide and straighter on the inner than on the outer lip. Surface of the shell marked with fine, raised, revolving lines, from two to four of which occupy the space of one millemeter and by transverse lines of growth.

Remarks.—This species is a peculiar shell which cannot be mistaken for any other form in the Cretaceous faunas of New Jersey. It occurs commonly in both the Merchantville and Woodbury formations in the form of internal casts, and the external impressions preserving the surface features of the shell are frequently met with. The type specimen was from the Woodbury clay near Haddonfield, and it seems to have been the only individual previously observed, and even this specimen has apparently been destroyed or lost from the collection of the Philadelphia Academy of Science. The dimensions given above are those of a specimen from Lorillard, where the species seems to have grown to a notably larger size than at Haddonfield, judging from the single type specimen, which was not over 10 mm. in height. This difference in size in the specimens from the two localities accords with a similar difference noted among other species, although it is possible that the type specimen was a young individual, or only the apical portion of a larger shell.

Formation and locality.—Merchantville clay-marl, near Matawan (101), near Jamesburg (141), Lenola (163); Woodbury clay, Lorillard (102), near Haddonfield (183).

Geographic distribution.—New Jersey, Southern States.

Family CERITHIIDAE.

Genus CERITHIUM Bruguiere.

Cerithium pilsbryi Whitfield.

Plate LXXXI., Figs. 3–5.

1893. *Cerithium Pilsbryi* Whitf., The Nautilus, vol. 7, pp. 38 and 51, pl. 2, fig. 3.
1905. *Cerithium pilsbryi* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 22.

Description.—"Shell elongate and slender; volutions numerous, number not determined, very gradually expanding with additional growth; apex and aperture unknown. Volution slightly convex between the sutures, and ornamented by a band of small oblique nodes immediately below the suture; also by a series of larger vertical folds which extend across the exposed part of the volution, below the upper band of nodes, and numbering something more than half as many to the volution as the nodes above. There are also very fine spiral striæ almost too fine to be seen without magnifying. The lines of growth are fine but distinct, and take a broad sweeping backward curve below the sutures." (Whitfield.)

The dimensions of one of the most complete individuals observed, a specimen not complete to the aperture and with the apex of the shell missing, are: height, 27 mm.; maximum diameter, 11 mm.; number of volutions showing 9, apical angle 23°. A specimen 18 mm. in length, with the apex nearly complete has nine volutions.

Remarks.—This is one of the common species at Lenola. The internal casts are rather loose coiled, with low, somewhat indistinct vertical nodes, but not retaining any indication of the narrow, nodose, revolving band seen at the upper margin of the volution on the external surface of the shell. Good impressions of the exterior of the shell are sometimes met with, and it is upon casts taken from such natural moulds that the external characters of

the shell are best shown. The form of the aperture of the shell has not been observed, so that the generic relations of the shell cannot be determined with certainty; it seems likely, however, that it is not a true *Cerithium*.

Formation and locality.—Merchantville clay-marl, Lenola (163), Merchantville (162).

Geographic distribution.—New Jersey.

Family APORRHAIDAE.

Genus ANCHURA Conrad.

Anchura rostrata (Gabb).

Plate LXXXI., Figs. 7–9.

1860. *Rostellaria rostrata* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 390, pl. 68, fig. 7.
1861. *Gladius rostratus* Gabb, Synop. Moll. Cret. Form., p. 111 (55).
1864. *Anchura* (*Drepanochilus*) *rostrata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 19.
1868. *Anchura rostrata* Con., Cook's Geol. N. J., p. 729.
1875. *Rostellaria rostrata* Con., Kerr's Geol. N. Car., App., p. 12.
1892. *Alaria rostrata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 119, pl. 14, figs. 5-6.
1905. *Alaria rostrata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 23. (Not *Anchura rostrata* Con., Kerr's Geol. N. Car., App., p. 12, pl. 2, fig. 28.)

Description.—"Shell of only moderate size; spire elevated, forming an apical angle of about 35°, but somewhat variable in different specimens; whorls about six in number, very slightly convex between the sutures, which are not very strongly marked, and are ornamented by rather closely arranged vertical folds, smaller, more numerous, and more closely arranged on the upper than on the body whorl; those on the last whorl become smaller, shorter, and more indistinct toward the expanded lip, on the back

of which they become obsolete; on all the upper whorls the folds extend from suture to suture, but on the last one they are marked only on the upper or larger parts; outer lip expanded, forming a broad, wing-like extension which is prolonged below along the moderately long rostral beak, and above is extended into an obtusely pointed hook-like process from its outer upper border. This feature I have seen entire only on the type specimen, though several are before me which show the expansion of the lip. No keel-like ridge marks the back of the lip, as in most of the species of this group from the Cretaceous beds of the Upper Missouri region." (Whitfield.)

Remarks.—This species is one of the abundant gastropods in the Merchantville clay, and it only occurs commonly elsewhere, so far as it has been observed, at one locality in the Wenonah sand. Whitfield illustrates two specimens, one from Holmdel and one from Haddonfield. The first of these must be from the Navesink marl, and is, perhaps, a small individual of *A. pennata,* and the last is from the Woodbury clay and is correctly identified. The type specimens used by Gabb are certainly from the Merchantville clay-marl near Burlington. The species may be distinguished from all other members of the genus in the New Jersey faunas by its smaller size, rarely attaining a height of over 25 mm. It is essentially a miniature form of *A. pennata,* and, perhaps, should not be considered as distinct from that species, and there seems to be no basis whatever for referring the species to a genus different from that to which other New Jersey shells of this type are referred, as has been done by Whitfield. The specimens from the Wenonah sand near Crawfords Corner seem to be essentially identical with the Merchantville specimens in form and size; a single individual preserves the expanded outer lip, but it is smaller than the lip of full grown Merchantville specimens, and lacks the outer posterior angle. This difference may be due, however, to the immature condition of the lip on the specimen, since the growth lines on some Merchantville specimens indicate that the lip has passed through a similar form before reaching its mature form.

Formation and locality.—Merchantville clay-marl, near Mata-

wan (101), Lenola (163), Merchantville (162); Woodbury clay, Crosswicks (168), near Haddonfield (164, 165, 183); Wenonah sand, near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey, Mississippi, Texas.

Anchura pennata (Morton).

Plate LXXXI., Figs. 10–17.

1834. *Rostellaria pennata* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 48, pl. 19, fig. 9.
1861. *Gladius pennatus* Gabb, Synop. Moll. Cret. Form., p. 111 (55).
1864. *Rostellaria* (?) *pennata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 20.
1868. *Anchura pennata* Con., Cook's Geol. N. J., p. 729.
1892. *Rostellaria compacta* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 108, pl. 13, figs. 18–21.
1892. *Rostellaria spirata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 109, pl. 13, figs. 16–17.
1892. *Anchura pennata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 115, pl. 14, figs. 7–8.
1892. *Anchura* (*Drepanochilus*) *compressa* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 117, pl. 13, figs. 22–25.
1905. *Anchura pennata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 22.
1905. *Rostellaria compacta* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 23.
1905. *Rostellaria spirata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 23.

Description.—"Shell elongate, spire elevated and consisting of from six to seven volutions, which are only moderately convex between the suture lines, the latter being well marked but not deep; apical angle not more than 30°, but often less; last volution proportionally large and with a somewhat extended rostral beak, slender and straight; lip broadly expanded and

extended in a narrow border along the side of the beak to a point opposite the base or swell of the volution, where it rapidly widens out into the broad wing-like lip, which reaches somewhat over the next volution above but apparently not forming a posterior canal. The outer posterior angle of the expanded portion is prolonged into a narrow, recurved, falciform process of greater or less extent; volutions marked by oblique longitudinal folds, which extend from suture to suture on all the upper volutions, but become obsolete just above the middle on the body portion of the last one, and are entirely obsolete on the back of the expanded lip. On the upper volutions the folds are closely arranged, but on the lower they are more distant and more strongly marked, while on the body part of the last one they are quite strong and almost node-like, even on many of the internal casts." (Whitfield.)

Remarks.—Morton's description of this species does not agree well with his illustration of the same, and as there is some doubt as to the type specimen, it is not quite clear just what the species is. It is altogether probable, however, that the specimens which Whitfield has illustrated under this name are true representatives of the species, and it will be so considered here. However, Whitfield has described three other species as new, from specimens which are certainly specifically identical with his examples of *A. pennata*, these species being *Anchura compressa, Rostellaria compacta* and *Rostellaria spirata*. This species is represented by numerous casts in the faunas of the Navesink marl, where it is one of the commonest species of gastropods. These casts are usually incomplete towards the aperture, so that the expanded lip is rarely preserved, and they vary considerably in the strength of the vertical nodes of the shell, many of them being essentially smooth, although in the shells themselves these nodes were, doubtless, uniformly present. In a large series of specimens certain ones may be selected which agree more closely with one of Whitfield's supposed species than another, but they all run together to such a degree that it is not possible to draw specific lines between them. All of Whitfield's types have been studied in this connection.

It is possible that this species should also include *A. rostrata,* which differs chiefly in its smaller size.

Conrad has illustrated a specimen from Snow Hill, N. Car.,[1] under the name *Anchura rostrata* Mort., which he afterwards corrected to *Anchura pennata.*[2] This shell, however, is distinct from the one here referred to *A. pennata,* and probably represents an undescribed form.

Formation and locality.—Navesink marl, Atlantic Highlands (108), Middletown (113[1], 113[2]), near Crawfords Corner (126[7]), near Holmdel (128[5], 127), near Freehold (133), near Walnford (148[2]), Crosswicks Creek (149, 147[3], 147[4], 195), near Jacobstown (150), near Mount Laurel (166), Mullica Hill (169), Freehold, Marlboro, Cream Ridge (Whitfield).

Geographic distribution.—New Jersey, Alabama.

Anchura pergracilis Johnson.

Plate LXXXI., Figs. 18–19.

1898. *Anchura ? pergracilis* Johns., Proc. Acad. Nat. Sci. Phil. (1898), p. 463, text fig. 2.

1905. *Anchura pergracilis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 22.

Description.—"Shell fusiform, whorls convex, the body whorl with about 18 and the spiral whorls with 15 equidistant, flexuous, longitudinal ribs; numerous fine revolving lines, more prominent between the ribs and somewhat obsolete on the angles of the ribs, cover the entire shell; suture deeply impressed. The length of the largest specimen (including the two apical whorls, which are wanting), is about 20 mill." (Johnson.)

Remarks.—This species was based upon a young individual upon which the expanded lip of the adult has not been developed. It would be impossible to identify the species from internal casts, the condition in which the New Jersey Cretaceous fossils are usually preserved, but it can always be recognized from the markings of the shell itself.

[1] Kerr's Geol. N. Car., App., p. 12, pl. 2, fig. 28.

[2] Proc. Acad. Nat. Sci. Phil. (1876), p. 275.

Formation and locality.—? Cliffwood clay, Cliffwood Point (185); Woodbury clay, near Matawan (103), deep well-boring, Mount Laurel (Johnson).

Geographic distribution.—New Jersey.

Anchura solitaria Whitfield.

Plate LXXXI., Fig. 6.

1892. *Anchura solitaria* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 117, pl. 14, fig. 9.

1905. *Anchura solitaria* Johns., Proc. Accad. Nat. Sci. Phil. (1905), p. 22.

Description.—Shell small, with an elevated spire of about six volutions, the dimensions of a very perfect specimen being: total height, from end of anterior canal to tip of spire, 32 mm.; height of spire, 15 mm.; diameter of outer volution, 11 mm. Outer volution produced anteriorly into a rather long, slender anterior canal; the outer lip produced postero-laterally into a long, slender slightly curved, spine-like process. The volutions of the spire moderately and regularly convex, with moderately impressed sutures, marked by narrow, rounded, vertical nodes which extend from suture to suture, from 16 to 20 being present on each volution; upon the outer volution the vertical nodes extend only about one-third of the length of the volution below the suture, and at their base, towards the aperture, a revolving angle is gradually developed which continues into the spine-like lateral extension of the aperture.

Remarks.—This species was originally described from a very imperfect specimen in which the anterior canal and the extension of the aperture were not preserved. The description here published has been drawn up from a very complete specimen in the recent collections of the Survey. Some impressions of the exterior of the shell show, in addition to the characters enumerated above, that the outer volution is nearly smooth for a distance below the revolving angular ridge, and then below this smooth area it is marked by rather fine revolving costæ; the entire surface of the shell is marked by very fine revolving striæ.

Formation and locality.—Merchantville clay-marl, near Jamesburg (139, 140, 141).

Anchura abrupta Conrad.

Plate LXXXII., Figs. 1–6; Plate LXXXIII., Figs. 3–4.

1860. *Anchura abrupta* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 284, pl. 47, fig. 1.
1861. *Anchura abrupta* Gabb, Synop. Moll. Cret. Form., p. 94 (38).
1864. *Anchura abrupta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 19.
1868. *Anchura abrupta* Gabb, Am. Jour. Conch., vol. 4, pp. 145, 149, pl. 14, fig. 13.
1883. *Anchura abrupta* Tryon, Struct. and Syst. Conch., vol. 2, p. 194, pl. 60, fig. 83.
1892. *Turbinopsis major* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 103, pl. 12, figs. 21–23 (not figs. 15–16).
1892. *Rostellaria Hebe* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 111, pl. 14, figs. 11–14.
1892. *Anchura abrupta* ? Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 113, pl. 14, figs. 1–3.
1892. *Anchura abrupta* var. *acutispira* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 114, pl. 14, fig. 4.
1892. *Anchura pagodaformis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 116, pl. 14, figs. 15–16.
1892. *Rostellaria nobilis* Whitf., pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 186, pl. 23, figs. 16–17.
1905. *Anchura abrupta* var. *acutispira* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 22.

Description.—Shell with a rather high spire having an apical angle of about 30°, and a comparatively short body volution, with a slender rostrate, anterior canal; the dimensions of a moderately large internal cast retaining a little more than three

volutions, and incomplete at both the apex and the anterior extremity, are: length, 51 mm.; greatest diameter, 30 mm.; height of aperture, 21.5 mm.; width of aperture, 10.5 mm. If this specimen were complete it would have an additional height at the apex of about 20 mm., and an anterior beak about 30 mm. in length. The outer lip of the aperture is produced and terminates in two unequal pointed processes—one directed forward and the other backward. Surface of the shell marked by a rather strong, nodose, subangular, revolving keel at a little above the mid-height of the outer volution. Upon the expanded portion of the outer lip this keel curves upward to the posterior process of the lip. Above and below the median keel the surface is marked by moderately broad, rather depressed revolving ribs, and by less conspicuous vertical markings. On the internal casts, in which condition only the species has been seen in New Jersey, the surface is marked in the younger individuals by more or less indistinct revolving and vertical ribs, which evidently were obliterated by the internal thickening of the shell, since the larger individuals are all smooth. The aperture in the casts is narrowly subelliptical in outline, the outer side being a little more strongly curved than the inner. The columellar cavity left in the casts is rather broad and is not marked by revolving folds.

Remarks.—In New Jersey this species is known only in the condition of internal casts, which are all imperfect, the apex of the spire and the anterior rostral extension and the outer lip of the aperture being lacking in every example observed. A careful examination of the types of Whitfield's species *Anchura pagodaformis, Rostellaria nobilis* and *Rostellaria hebe,* leads to the conclusion that all of them are members of the same species, and a comparison of the specimens with numerous examples from the South in the collections of the National Museum at Washington fails to show any characters by which they can be separated from *Anchura abrupta.* A part of the specimens described by Whitfield as *Turbinopsis major* also seem to belong here. The casts which Whitfield has identified as *A. abrupta* and its variety *acutispira* are also representatives of the same species. These internal casts differ more or less at different stages in their

growth, and the younger ones have the external markings of the shell more strongly impressed, as if the shell were thinner during its earlier growth, becoming thickened internally later so as to abscure the external markings. Entirely similar casts occur at Prairie Bluff, Alabama, and elsewhere in the south.

Whitfield has referred his species *R. nobilis* to the "Upper," or Manasquan marl, with a query, but there is no data with the specimen, and from its lithologic characters it seems to be more properly referred to the Navesink, the horizon to which the species seems to be restricted.

Formation and locality.—Navesink marl, near Crawfords Corner (126[7]), Mullica Hill (169).

Geographic distribution.—New Jersey, Alabama, Mississippi.

Anchura arenaria (Morton).

Plate LXXXIII., Fig. 5.

1834. *Rostellaria arenarum* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 48, pl. 5, fig. 8.
1861. *Gladius arenarum* Gabb, Synop. Moll. Cret. Form., p. 110 (54).
1864. *Rostellaria* (?) *arenarum* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 20.
1868. *Anchura arenarum* Con., Cook's Geol. N. J., p. 729.
1876. *Anchura arenarum* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 298.
1892. *Anchura arenaria* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 112, pl. 14, fig. 10.
1905. *Anchura arenaria* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 22.

Description.—Shell rather strong and robust, about 50 mm. in length when complete and 24 mm. in width. Volutions probably four and one-half or five in number, strongly rounded, rapidly decreasing in size upward; suture strongly marked; aperture narrow, the lip unknown, the rostrum apparently quite short. Each volution marked by 10 or 12 vertical plications or folds,

which are strongly marked upon the convex portion, but become obsolete towards the sutures above and below, while on the body volution they are not visible below the upper two-thirds, the lower third being destitute of markings. On the outer half of the last volution the folds are indistinct or obsolete; the folds appear to have been somewhat sigmoidally curved in passing from above downward, being directed slightly forward below.

Remarks.—This species is known only from Morton's type specimen, which is only a fragmentary cast scarcely sufficient to show its specific characters, although it is probable that Morton would have included here some specimens which are referred to *A. pennata* in the present report, since he states that the species is "common throughout the blue marls." The type specimen, however, seems to be a good species, distinguished from *A. pennata* by its more strongly marked vertical nodes and its more strongly convex volutions.

Formation and locality.—Navesink marl, New Jersey (Morton).

Geographic distribution.—New Jersey.

Genus PTEROCERELLA Meek.

Pterocerella tippana (Conrad).

Plate LXXXIII., Figs. 1–2.

1858. *Harpago tippana* Con., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 3, p. 331, pl. 35, fig. 25.
1861. *Harpago Tippanus* Gabb, Synop. Moll. Cret. Form., p. 112 (56).
1864. *Pterocerella tippana* Meek, Check List Inv. Foss. N. A., Cret. and Jur., pp. 20 and 36.
1868. *Pterocerella Tippana* Gabb, Am. Jour. Conch., vol. 4, p. 146, pl. 14, fig. 20.
1883. *Pterocerella Tippana* Tryon, Struct. and Syst. Conch., vol. 2, p. 195, pl. 60, fig. 90.

Description.—Shell with a spire of moderate height, with about six volutions, having an apical angle of about 48°. The

dimensions of a nearly perfect specimen from Texas are: total height, exclusive of the wing-like extensions of the aperture, 35 mm.; height of spire, 18 mm.; maximum diameter of body volution, 23 mm.; extension of the processes on the border of the outer lip from 18 mm. to 33 mm. The volutions of the spire are marked by a revolving keel a little below the mid-height of each volution, the sutures not impressed below the surface of the spiral, concave band between the carinæ of succeeding volutions. Greatest height of the body volution, exclusive of its wing-like extensions, about equal to the greatest height of the spire, marked by a second less sharply angular revolving rib, which is situated about as far below the upper carina as that is below the upper suture, and by three other less distinctly marked ones near the anterior margin, the two lower of which are distinctly recurved. When the outer lip of the aperture is complete it is produced into six elongate, divergent, conspicuous, wing-like processes, which are strengthened along their median lines by thickened ribs or carinæ; the median carinæ of five of these processes being continuations of the ribs upon the body volution of the shell. The most posterior of the processes is a branch from near the base of the one next to it, and its median line is subparallel to the axis of the spire. Surface of the shell marked only by fine, inconspicuous lines of growth.

Remarks.—This species was originally described from a portion of the body volution and parts of the upper wing-like processes of the outer lip, and no figure or description of a complete example has previously been given. The nearly perfect individual which has served as a basis for the foregoing description and the accompanying illustration of the species is from Texas, and is preserved in the collection of the National Museum at Washington. In New Jersey no example preserving the wings of the aperture has been observed, but one small, although nearly perfect, internal cast exclusive of these processes has been collected, which differs in no essential respect from the larger example from Texas.

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey, Mississippi, Texas.

Family STROMBIDAE.

Genus PUGNELLUS Conrad.

Puguellus densatus Conrad.

Plate LXXXIII., Fig. 6.

1858. *Strombus densatus* Con., Jour. Acad. Nat. Sci. Phil., 2d Ser., vol. 3, p. 330, pl. 35, fig. 14.
1860. *Pugnellus densatus* Con. Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 284.
1861. *Pugnellus densatus* Gabb, Synop. Moll. Cret. Form., p. 128.
1864. *Pugenellus densatus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 20.

Description.—Internal casts of median size, subovate in form, the diminsions of a nearly complete one being: height, 35 mm.; greatest diameter, 20 mm.; height of aperture, about 22 mm.; width of aperture, 7.5 mm. Volutions about four in number, the suture well defined, the height of the spire less than one-half the total height of the shell. Volutions of the spire gently convex and nearly vertical for two-thirds of this height from the suture below, curving much more strongly above to the upper suture. Surface of the cast without well-defined markings.

Remarks.—This species is represented in the New Jersey collections only by internal casts, which in no case preserve the form of the expanded and thickened outer lip. It is not possible to identify these casts with absolute certainty, but on comparison with authentic specimens of the species in the National Museum at Washington, the New Jersey examples seem to belong here.

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey, Mississippi.

Genus ROSTELLARIA Lamark.

Rostellaria curta Whitfield.

Plate LXXXIII., Figs. 9–13.

1892. *Rostellaria curta* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 109, pl. 13, figs. 9–13.

Description.—"Shell small and comparatively short for a species of the genus; spire short, the apical angle being about 45° in some specimens, and in other individuals rather less; volutions convex, four or five in number, only four in the casts; sutures deeply marked, indicating a comparatively thick shell; body volution large, half as long as the entire length of the cast, or sometimes three-fifths of the entire length; base of the body volution extended in front; aperture equaling one-half the length of the cast; elongate elliptical in outline, acute at the upper angle and the margin extending above the line of the suture where the lip has extended upon the preceding volution; lower margin of the aperture prolonged and narrow; outer margin more convex than the inner; columellar cavity rather large, indicating a strong and thickened columella, which has been smooth and without any indications of folds or markings; surface of the volutions marked by distant but not very strong vertical folds, which are only seen on the internal cast upon careful examination; surface of the shell and features of the lip and posterior canal unknown." (Whitfield.)

Remarks.—The broad columellar cavity in the casts of this species gives it a strong resemblance to the casts which have been referred to the genus *Turbinopsis* by Whitfield, and so far as the characters of the casts are concerned there seems to be no reason for placing this species in a different genus than *Turbinopsis elevata*. Indeed, in many respects these two species seem to be closely allied, but *R. curta* is smaller, with a shorter and more pointed spire. Whitfield's illustration showing the revolving costæ near the aperture (his fig. 10), is much overdrawn,

as these markings are exceedingly faint upon the specimen and may be easily overlooked.

Formation and locality.—Navesink marl, Crosswicks Creek (Whitfield).

Geographic distribution.—New Jersey.

Rostellaria fusiformis Whitfield.

Plate LXXXIII., Figs. 16–17.

1892. *Rostellaria fusiformis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 110, pl. 13, figs. 14–15.

Description.—"Shell small, slender and fusiform; spire elevated and slender, the apical angle being about 20° or 25°; volutions slender, slightly convex on their exposed surfaces; four only preserved in the cast, but there have been four or five more above, making eight or more in all; body volution greatly prolonged in front, forming a long slender beak with a proportionally strong axis, leaving quite a good-sized axial cavity in the cast; aperture long and narrow, pointed above and below, the upper canal being extended upon the preceding volutions to an unknown extent; volutions marked by numerous, closely-arranged, vertical folds, 12 or more to the whorl." (Whitfield.)

Remarks.—This species may be distinguished from *R. curta* by its more slender form. It is known only in the condition of internal casts.

Formation and locality.—Navesink marl, Crosswicks Creek (Whitfield).

Geographic distribution.—New Jersey.

Family CYPRAEIDAE.

Genus CYPRAEA Linneus.

Cypraea mortoni Gabb.

Plate LXXXIV., Figs. 1–2.

1860. *Cypræa Mortoni* Gabb., Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 391, pl. 68, fig. 9.

1861. *Cypræa Mortoni* Gabb, Synop. Moll. Cret. Form., p. 104 (48).
1864. *Cypræa Mortoni* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 19.
1868. *Cypræa Mortoni* Con., Cook's Geol. N. J., p. 729.
1892. *Cypræa* (*Aricia*) *Mortoni* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 120, pl. 15, figs. 1–3.
1905. *Cypræa mortoni* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 23.

Description.—"Ovate; (casts) spire enveloped; mouth finely crenate on both sides; shell widest about the middle; no markings on the cast." (Gabb.)

Remarks.—Only two specimens of this species from New Jersey have been observed, one of them being the specimen used by Gabb as the type of the species. This type specimen is so imperfect that only the generic characters of the shell are certainly retained. It gives evidence, however, that it is an adult individual, so that about the only character of any specific value at all is its small size. The specimen is 17 mm. long and 13 mm. wide; it is broadly ovate in outline; the spire is flat and the cast is most ventricose about one-third of its length from that end, with a slight indication of angularity at the point of greatest diameter on the outer half of the last volution. The outer lip shows the infolding to a slight extent, but there are no indications of the fine crenulations of the lip nor of the opposite side of the aperture mentioned in the original description. This character was probably seen only upon the southern specimen, which was also included among the types of the species. The exterior of the cast is entirely smooth. The second specimen is also an internal cast. It differs from the type in being a little more slender, its dimensions being: length 21 mm., and width, 12.3 mm. Its condition of preservation is similar as to that of the type and little more than its generic characters can be detected.

Formation and locality.—Navesink marl, Atlantic Highlands (108), Burlington County (Gabb).

Geographic distribution.—New Jersey, Alabama.

Family DOLIIDAE

Genus PYRULA Lamark.

Pyrula precedens (Whitfield).

Plate LXXXIV., Figs. 3-4.

1892. *Ficus precedens* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 122, pl. 15, figs. 7-8.

Description.—"Shell small, pyriform; volutions about three, very ventricose, inflated in the upper part, rapidly attenuated below and contracted to form a moderately long, slender canal and beak, which is very slightly bent; spire low, but the inner volutions distinctly showing above the outer ones, with a well-defined suture; aperture elongate-elliptical, prolonged below to the end of the canal, which is very narrow; surface of the shell marked by 12 principal prominent, spiral carina, between which there is in each space a single subordinate ridge showing on the cast; toward the lower part of the volution and on the beak they are more equal in size, and on the body of the volution the principal carina are nodose, or serrated, from the crossing of transverse ribs which pass across the volution in a nearly straight line parallel to the margin of the outer lip of the aperture. In a fragment of the matrix, from near the inner part of the outer whorl the principal spiral ridges are seen to be sharply carinate, and the transverse striæ fine and numerous; columella without ridges or folds of any kind." (Whitfield.)

Remarks.—No specimens which can be referred to this species have been met with in the recent collections of the Survey, and the type seems to have been lost or destroyed. The species resembles some of those which have been referred to the genus *Pyropsis* or *Perrisolax,* especially *P. retifer.* The casts of *P. precedens,* however, do not show so large a columellar cavity and the anterior beak is more slender. The spiral ridges are also more numerous and more sharply elevated than in *P. retifer,* and the decided alternation among them is a distinguishing character.

Formation and locality.—Navesink marl, Holmdel (Whitfield).

Geographic distribution.—New Jersey.

Family TRITONIDAE.

Genus TRITON Montfort.

Triton lorillardensis n. sp.

Plate LXXXIV., Figs. 5–6.

Description.—The dimensions of the type specimen, with some restoration, are: height, 25 mm.; height of spire, 14 mm; greatest diameter, 15 mm.; apical angle, about 40°. Shell with probably five or six volutions, the suture well defined, the outer volution produced below into a very short anterior canal. Surface of the volutions of the spire convex from suture to suture, the curvature a little flattened above, with about 12 strong subangular vertical nodes or varices upon each volution, which extend from suture to suture and are separated by broad concave areas. Upon the outer volution the varices become obsolete below, and the surface becomes concave as it passes into the short anterior canal. Aperture subovate in outline, somewhat oblique, pointed below, about twice as high as wide; at the lower extremity of the columellar lip in the cast three notches can be detected which seem to indicate the presence of three somewhat obscure revolving columellar folds; the outer lip is marked by revolving ribs internally. The surface of the shell is marked by revolving costæ about one millimeter apart, with the spaces between filled with exceedingly fine revolving lines; the entire surface is also marked with exceedingly fine transverse lines of growth.

Remarks.—The type of this species consists of an incomplete internal cast which has been restored to its normal form so far as possible, and a partial impression of the exterior, which has furnished the character of the finer surface markings. Upon the casts the vertical nodes are well shown, but are broader and rounder than on the shell itself, and the stronger revolving costæ are present towards the aperture.

Formation and locality.—Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey.

Triton praecedens Whitfield.

Plate LXXXIV., Figs. 7–8.

1892. *Triton* (*Epidromus*) *præcedens* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 58, pl. 5, figs. 6-7.

Description.—"Shell small and moderately slender, spire elevated, longer than, or about equal to, the length of the body volution and anterior beak, as viewed from the back of the shell; apical angle of the spire between 30° and 35°; volutions quite ventricose, with strongly marked sutures; principal varices occuring at about every two-thirds of a volution, but with secondary varices between, visible on the casts but not definitely enough to give a positive idea of their exact number, yet apparently three on the body volution; each of the principal varices marked by about seven well defined depressions on the back, indicating that number of spiral ridges on the shell and protuberances on the inner margin of the lip; aperture of medium size, semi-lunate, the outer lip only moderately expanded; columella slender, and anterior beak of moderate length; number of volutions not definitely ascertained, as the specimens are imperfect." (Whitfield.)

Remarks.—This species is known only from the Navesink marl, but it is not one of the common members of the fauna of that formation. The species may be recognized by the impressions of the internal varices of the shell upon the surface of the internal casts.

Formation and locality.—Navesink marl, near Walnford (149), near Jacobstown (150), Mullica Hill (Whitfield).

Geographic distribution.—New Jersey.

Genus TRACHYTRITON Meek.

There is much doubt as to the correct generic position of the species which were described by Whitfield as members of the genus *Trachytriton*. They are only known from the internal casts, and for want of any definite knowledge of their true generic characters, they will be allowed to remain where Whitfield has

placed them. The species described by Whitfield as *Triton praecedens,* however, seems to more nearly fit the genus *Trachytriton* than do these species which are placed in the genus.

Trachytriton ? atlanticum Whitfield.

Plate LXXXIV., Figs. 11–14.

1892. *Trachytriton atlanticum* Whitf., Pal. N. J., vol 2 (Monog. U. S. G. S., vol. 18), p. 59, pl. 5, figs. 8-11.

Description.—"Shell small, the casts seldom reaching a length of more than an inch and a quarter; spire with an apical angle of about 40° to 45°; volutions four and a half to five in number, rather convex and moderately distinct, the sutures in the cast being distinct and the spaces left by the removal of the shell quite considerable; last volution large, forming more than half the entire length, and being as long below the point of greatest diameter as the length of the spire above, giving an equally biconical or fusiform feature to the cast, with a moderately long and somewhat curved beak and canal; aperture large, pointed above and slightly extended below; narrow-elliptical in outline, with the outer margin rather more convex than the inner one; lip of the outer volution apparently slightly deflected; the surface of the volutions have been marked by revolving lines, at least in the lower part, as is shown by their remains on the surfaces between the volutions of the cast; and by proportionally strong, vertical folds, three of which in each volution have been stronger than the one or two intermediate ones, and have left their deeper impression both on the surface of the cast and on the imprint of the exterior, as seen between the whorls." (Whitfield.)

Remarks.—In his illustrations of this species, Whitfield made the vertical ribs of the shell much more conspicuous than they really are upon the specimens. It does not seem to be altogether certain that the generic reference of the species is correct, the strongly defined pitted furrows upon the internal casts, left by the denticulate internal varices, which are said by Meek[1] to be

[1] Rep. Inv. Cret. and Tert. Foss. Up. Mo., p. 303.

so characteristic of the genus, are not present at all upon the New Jersey specimens of either this species or of the others referred to the genus by Whitfield.

Formation and locality.—Navesink marl, Atlantic Highlands (108), near Freehold (133), near Walnford (148[2]), Crosswicks Creek (149, 195).

Geographic distribution.—New Jersey.

Trachytriton ? holmdelense Whitfield.

Plate LXXXIV., Figs. 9–10.

1892. *Trachytriton ? Holmdelense* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 60, pl. 5, figs. 16-17.

Description.—"Shell of medium size; spire moderately elevated, having an apical angle of 50° or over; is composed of about five very rotund volutions, and forms fully two-thirds of the entire length of the cast when viewed from the back of the specimen; below the point of greatest diameter the cast is short and the beak only slightly extended beyond the general rotundity of the body volution; suture lines between the volutions in the cast clear, distinct, and deep; aperture rather broadly elliptical; rounded above; slightly pointed below and straightened on the inner side below the middle of its height; columella moderately strong and smooth; surface of the cast marked by vertical folds, 13 or 14 to the volution; these folds distinctly bend backward in the middle in crossing the whorl, and are again directed forward below, forming a broad sinuosity in crossing the whorl; no evidence of revolving lines discernible on any of the specimens." (Whitfield.)

Remarks.—This species has not been met with in the recent collections and the type specimen seems to have been lost or destroyed. The species is certainly not a member of the genus *Trachytriton*, but what its true generic relations may be cannot now be determined.

Formation and locality.—Navesink marl, Holmdel (Whitfield).

Geographic distribution.—New Jersey.

Trachytriton ? multivaricosum Whitfield.

Plate LXXXIV., Figs. 15–18.

1892. *Trachytriton ? multivaricosum* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 61, pl. 5, figs. 12-13.

Description.—"Shell of medium size and rather ventricose, with an elevated spire, which is composed of rounded and ventricose volutions, and has an apical angle of about 50°; volutions four and a half or five in the cast, the number not definitely known, the specimens being imperfect at the apex; sutures very distinct and marked; body volution proportionally large and full, especially in the upper part, and slightly extended below; the beak rather long, slightly twisted, and provided with a rather large canal; aperture large, elongate-elliptical, acute above and extended below, the length about three times the width; columella, as shown by the cavity left by its removal, rather strong and perfectly smooth; surface of the cast showing remains of numerous closely arranged, vertical folds, marking the upper portion of the volutions, but becoming indistinct on the outer half of the last one; three of these on each volution slightly stronger than the others; also, marked by spiral lines or ridges, which have left deep grooves on the inner surface of the volutions of the cast, and also mark the outer half of the body whorl, becoming quite distinct on the margin of the lip, indicating crenulations or denticulations on its inner surface." (Whitfield.)

Remarks.—This species resembles *T. atlanticum,* but it is more robust with rounder volutions and usually with somewhat more conspicuous and more numerous vertical nodes upon the casts. The illustrations of the species published by Whitfield, show the vertical nodes and the revolving costæ near the aperture, much more clearly than they can be seen on the specimen itself. The revolving costæ are so faint as to be scarcely recognizable upon the specimen at all, and upon only one of the type specimens are the vertical nodes at all noticeable.

Formation and locality.—Navesink marl, Crosswicks Creek, near New Egypt (Whitfield).

Geographic distribution.—New Jersey.

Super-family RACHIGLOSSA.

Family BUCCINIDAE.

Genus PERISSOLAX Gabb.

Perissolax dubia (Gabb).

Plate LXXXV., Figs. 1–5.

1860. *Purpuroides ? dubia* Gabb, Proc. Acad. Nat. Sci. Phil. (1860), p. 94, pl. 2, fig. 11.
1861. *Purpuroidea ? dubia* Gabb, Synop. Moll. Cret. Form., p. 129 (73).
1864. *Purpuroidea ? dubia* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Purpuroidea ? dubia* Con., Cook's Geol. N. J., p. 730.
1892. *Perissolax dubia* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 47, pl. 3, figs. 9-11.
1892. *Tritonidæ obesa* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 79, pl. 9, figs. 1-3.
1905. *Perissolax dubia* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 24.

Description.—"Shell of medium size, conical above, abruptly contracted below the largest part of the last volution, and extended in front into a short, somewhat slender beak; volutions about four, strong, convex on the surface, with well-marked sutures; apical angle in the vicinity of 50°; aperture ovate, somewhat acute at each end but prolonged below; surface marked by revolving ridges and by closely arranged vertical folds; of the former, there are 11, eight of which may be said to be above the middle of the volution, or above the peripherry, while three only are really below this point, and these more distant and somewhat stronger than the others, with distinctly concave spaces between, while the lower half of the space between the beak and the periphery seems to be destitute of ridges; vertical folds low and rounded, with concave interspaces of about an equal breadth with the folds, or the folds may be said to unite at their bases, occupying the entire space; 12 of them can be counted on the

outer half of the last volution; the folds bent slightly backwards from the suture to the center of the volution, and again very faintly forward at that point, below which they rapidly become obsolete, not showing on the under side of the volution." (Whitfield.)

Remarks.—This species occurs in the Navesink marl in the condition of internal casts, and as in the case of most of the gastropods known only as casts, its generic relations cannot be determined with certainty. The anterior canal has usually been destroyed upon the specimens. The shells which Whitfield has described under the name *Tritonidea obesa* prove, upon examination of the types, to be only small examples of *Perissolax dubia.*

Formation and locality.—Navesink marl, near Crawfords Corner (126[7]), Crosswicks Creek (195), Mullica Hill (169), Holmdel (Whitfield).

Geographic distribution.—New Jersey.

Perissolax trivolva Gabb.

Plate LXXXV., Fig. 6.

1860. *Fusus trivolvus* Gabb, Proc. Acad. Nat. Sci. Phil. (1860), p. 94.
1861. *Perissolax trivolva* Gabb, Synop. Moll. Cret. Form., p. 122 (67).
1864. *Perrisolax trivolva* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 23.
1868. *Perrisolax trivolva* Con., Cook's Geol. N. J., p. 730.
1892. *Perissolax trivolva* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 172, pl. 21, figs. 1-3.
1905. *Perissolax trivolva* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 24.

Description.—"Shell of medium size, ventricose, with a long, straight canal, once and a half as long as the length of the inner part of the body whorl above it. Spire very low, broad, conical; the apical angle being from 100° to 110°, the top of the volutions flattened in the direction of the slope of the spire, and the

inner volutions barely rising above the outer ones. Body whorl flattened on the periphery, forming a nearly vertical, flattened band of considerable depth, below which a second obliquely flattened space of somewhat less width occurs, thus forming the three angles on the body of the whorl from which the name was derived. Below the lower angle the surface slopes rapidly to the long, slender canal and beak. Aperture large, angular on the outside and contracted below at the canal, strongly modified on the inner margin by the preceding volution. Volutions faintly marked by distant varices and along the upper carina by a series of thin, rather closely arranged transverse nodes. No fine surface markings or spiral lines are perceptible on any of the specimens, all of which are internal casts in a rather coarse yellow limesand." (Whitfield.)

Remarks.—This is a well-marked species, and is one of those designated among the types of the genus *Perissolax*. Its characters are so distinct that it cannot be easily mistaken for any other shell in the Cretaceous faunas of New Jersey. It is known only from internal casts, which are preserved in a matrix which does not well preserve the surface characters of the shell, and the absence of spiral ribs or other marks upon the casts does not signify that they were absent from the shell itself.

Formation and locality.—Vincentown limesand, Timber Creek (Gabb and Whitfield).

Geographic distribution.—New Jersey.

Genus PYRIFUSUS Conrad.

Pyrifusus meeki Whitfield.

Plate LXXXV., Figs. 7–8.

1892. *Pyrifusus meeki* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 55, pl. 4, figs. 6-8.

Description.—"Shell moderately large for the genus, having a diameter of nearly 1¼ inches of the body whorl; subequally biconical in general outline; spire elevated, having an apical

angle, as seen in the cast, of somewhat less than 60°, with the spire slightly longer than the shell below, as viewed from the back of the last volution; volutions probably about four in number (the specimens being all imperfect), subangular on the periphery above the last one, which is biangular and obliquely flattened on the periphery, the lower angle less strongly marked and less prominent than the upper one, and both crossed by strong, rounded, vertical folds, which become obsolete just below the lower angulation, but form node-like prominences on them; base of the last volution strongly and rapidly contracted from the lower angulation, forming a short anterior prolongation or beak; the columella formerly quite slender, judging from the small perforation remaining in the cast, and destitute of folds or ridges; aperture large, angularly ovate, oblique and pointed below and strongly angular on the outer side; surface of the shell, except the vertical folds, unknown." (Whitfield.)

Remarks.—This seems to be a well defined species which can be easily distinguished from any of its associates by reason of the two revolving angles of the outer volution with the distinctly flattened surface between.

Formation and locality.—Navesink marl, Crosswicks Creek (Whitfield).

Geographic distribution.—New Jersey.

Pyrifusus mullicaensis (Gabb).

Plate LXXXV., Figs. 9–15.

1860. *Pleurotoma Mullicaensis* Gabb, Proc. Acad. Nat. Sci. Phil. (1860), p. 95, pl. 2, fig. 8.

1861. *Fusus Mullicaensis* Gabb, Synop. Moll. Cret. Form., p. 108 (52).

1864. *Fusus mullicaensis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 22.

1868. *Fusus ? Mullicaensis* Con., Cook's Geol. N. J., p. 730.

1892. *Pyrifusus mullicaensis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 52, pl. 4, figs. 16-19.

1892. *Neptunella Mullicaensis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 56, pl. 4, figs. 20-21.

1892. *Eripachya ? paulidinaformis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 77, pl. 3, figs. 16-17.
1892. *Pyrifusus cuneus* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 51, pl. 4, figs. 9-11.
1905. *Pyrifusus cuneus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 24.
1905. *Pyrifusus mullicaensis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 24.

Description.—Shell subfusiform, with about five volutions, of medium size or rather large, length above and below the point of greatest diameter nearly equal, spire obtusely conical with an apical angle of about 50°; the dimensions of a nearly complete internal casts are: total height, 36 mm.; greatest diameter, 20.5 mm.; height of spire, 13 mm.; height of aperture, 23 mm.; width of aperture, 9.5 mm. Volutions ventricose, with deep sutures, the outer one subangular on the periphery with the lower part somewhat attenuated; aperture large, elongate, subelliptical, more rounded externally than on the inner side; columellar cavity in the casts broad. Surface of the casts marked by numerous obliquely vertical folds which are strongest on the largest portion of the volutions; other surface characters unknown.

Remarks.—Whitfield referred his specimens to this species with a query, but there is no doubt as to the identity of the examples which he illustrates with Gabb's type of the species. In addition to the specimens which Whitfield has identified as members of this species, the example which he has described as *Neptunella mullicaensis* is only an exceptionally large individual of *P. mullicaensis,* as has been suggested by Johnson. Also the shells which the same author has described as *P. cuneus* are only somewhat more immature individuals of *P. mullicaensis,* and the same can be said of his *Eripachys ? paulidinaformis,* although in this latter shell the vertical nodes are somewhat less strongly developed than usual. The different individuals vary considerably in the strength and size of their vertical nodes, but no specific characters can be drawn on these grounds since all intergradations can be selected from a large number of indi-

viduals. In addition to the above, one of the specimens figured by Whitfield among the types of his *P. turritis*, the original of his figures 1 and 2, seems to be only a small example of this same species.

Formation and locality.—Navesink marl, Atlantic Highlands (108), Middeltown (113[1]), Crosswicks Creek (149, 195), near Mount Laurel (166), Mullica Hill (169), Freehold (Whitfield); Tinton beds, near Freehold (132).

Geographic distribution.—New Jersey, Alabama.

Pyrifusus macfarlandi Whitfield.

Plate LXXXV., Fig. 17.

1892. *Pyrifusus Macfarlandi* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 52, pl. 4, figs. 14-15.

Description.—"Shell below a medium size, short-conical or subglobose, shorter below than above the point of greater diameter, the low spire having an apical angle of nearly 90°, with the body volution proportionately large. Volutions four and a half to five in number, ventricose, the upper ones rounded on the exposed parts, even in the cast, with distinct, deeply marked sutures; body volution somewhat shouldered on the top, but not flattened; below it is short and very rapidly diminishing, so as to produce nearly a straight line from just below the point of greatest diameter to the margin of the cavity left by the removal of the columella or axis of the shell; aperture imperfect in form, but as seen by the section of the cast must have been acutely ovate, sharply pointed below and gradually widened upward for about two-thirds of its length, and rounded at the upper end; columella, as shown by the axial cavity, large and smooth, without folds or ridges; surface marked by numerous vertical folds, about eight of which may be counted on the outer half of the body whorl; these not seen on the cast below the point of greatest diameter, indicating their absence on the lower part of the volution in the living shell; no remains of spiral lines preserved on the specimen." (Whitfield.)

Remarks.—This species may be distinguished from *P. mullicaensis*, with which it is associated, by its comparatively shorter and broader form, and by the more numerous vertical node-like folds upon the shell. The surface markings of the shell have not been observed.

Formation and locality.—Navesink marl, Mullica Hill (169).

Geographic distribution.—New Jersey.

Pyrifusus erraticus Whitfield.

Plate LXXXV., Fig. 16.

1892. *Pyrifusus erraticus* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 50, pl. 4, figs. 4-5.

Description.—"Shell of medium size, a very fine specimen used, measuring 1¼ inches in length; nearly equally fusiform or biconical in general outline as viewed from the back; apical angle about 50°; volutions, about four in number, the last one large, subangular on the periphery, concave above, rounded below the middle, and contracted in the lower part; upper volutions convex; suture distinct; aperture elongate; canal short; the volutions crossed by nine or ten vertical plications, which are strong, prominent, and rounded on the larger part of the volution, and but faintly marked on the lower convexity of the last one, becoming obsolete before reaching the beak; the entire surface of the shell also marked by beautifully rounded, spiral lines, which are alternately larger and smaller, and very closely arranged; these again crossed by fine transverse lines of growth, which make a broad and rather strong retral curve from the suture to the most prominent part of the longitudinal plications, below which point they again bend forward to the swell of the volution below; columella and axis unknown." (Whitfield.)

Remarks.—In the recent collections of the Survey is a large, but somewhat imperfect internal cast of this species, which must have had a total height of 43 mm. when complete, which is considerably larger than Whitfield's type, with a height of but 31 mm. The species is a well-marked one and cannot be easily confused with any other in the Cretaceous beds of New Jersey.

Formation and locality.—Cliffwood clay, Cliffwood Point (105).

Geographic distribution.—New Jersey.

Genus HERCORHYNCHUS Conrad.

Hercorhynchus jerseyensis n. sp.

Plate LXXXV., Figs. 18–22.

Description.—The dimensions of the type specimen are: height, 29 mm.; height of spire, 7 mm.; greatest diameter, 17.5 mm.; apical angle about 75°. Shell pyriform with four or five volutions, the outer volution produced below into a rather short, curved anterior canal; suture moderately impressed. The volutions of the spire subangular about midway between the sutures, the angulation marked with obscure nodes, both angulation and nodes being obsolete on the higher volutions. Body volution with a rather finely nodose revolving ridge or shoulder below the suture, just below which at the line of greatest diameter of the volution, is a row of rounded nodes, about 18 in number, with the intervening spaces about equaling in width the nodes themselves, some of the nodes are produced below for a short distance as obscure, rounded ridges; between the sutural ridge or shoulder and the row of nodes, the surface is concave; below the row of nodes the surface is broadly and regularly convex, becoming concave below as it passes into the anterior canal. Surface ornamented by obscure lines of growth which show a broad but slight sinuosity beneath the suture. Columella with two faint revolving folds.

Remarks.—The best specimen of this species which has been observed consists of a nearly complete internal cast with a partial mould of the exterior from which a plaster cast has been taken. Only the larger nodes, those near the aperture, are visible upon the cast. The species is especially characterized by its curved anterior canals. The folds of the columella are seen only as impressions in the cast, and are almost too faint to be detected except when the specimen is held in a certain position.

This species resembles *Strepsidura tippana* Con.,[1] a species which was afterwards placed by the same author in his genus *Hercorhynchus*.[2] The New Jersey shell differs from this form, however, in the absence of spiral markings.

Formation and locality.—Cliffwood clay, Cliffwood Point (185).

Geographic distribution.—New Jersey.

Genus Nassa Lamark.

Nassa globosa Gabb.

Plate LXXXVI., Fig. 1.

1876. *Nassa globosa* Gabb, Proc. Acad. Nat. Sci. Phil (1876), p. 282.

Description.—Shell subglobose, with a short anterior beak, spire moderately elevated, volutions six or more in number. The dimensions of a large, somewhat imperfect and distorted internal cast are: total height, 45 mm.; greatest width after correcting for the distortion, about 37 mm. Volutions of the spire marked by rather broad, vertical nodes which reach nearly from suture to suture, their greatest prominence being somewhat above the mid-height; body volution marked by similar nodes which are continued anteriorly, dying out about two-thirds of the distance from the suture to the anterior extremity, these nodes are broad, separated by about equally broad depressions, and are most prominent a little below the suture. Surface of the shell marked throughout by moderately coarse, depressed, revolving ribs, the distance from center to center of the larger ones upon the example whose dimensions are given above being about 2 mm.

Remarks.—This species has not been met with commonly in the New Jersey collections. The specimen here illustrated and

[1] Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 286, pl. 46, fig. 42.
[2] Am. Jour. Conch., vol. 4, p. 247.

whose dimensions are given above, has been compared with the type of the species and other examples in the collections of the Philadelphia Academy of Science and the National Museum, and its specific identity is certain. The examples from the southern localities show that the shell substance was thin. The New Jersey specimen is a modified internal cast and shows most of the external surface markings of the shell.

Formation and locality.—Wenonah sand, near Marlboro (130).

Geographic distribution.—New Jersey, North Carolina, Mississippi.

Genus Pyropsis Conrad.

Pyropsis richardsoni (Tuomey).

Plate LXXXVI., Figs. 2–5.

1854. *Pyrula (Richardsonii* Tuomey, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 169.
1860. *Tudicla* (*Pyropsis*) *perlata* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 288, pl. 46, fig. 39.
1860. *Rapa elevata* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 301, pl. 48, fig. 12.
1861. *Perissolax Richardsoni* Gabb, Synop. Moll. Cret. Form., p. 123 (67).
1861. *Tudicla elevata* Gabb, Synop. Moll. Cret. Form., p. 141 (85).
1861. *Tudicla* (*Pyropsis*) *perlata* Gabb, Synop. Moll. Cret. Form., p. 141 (85).
1864. *Tudicla* (*Pyropsis*) *perlata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 23.
1864. *Perissolax* (?) *Richardsoni* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 23.
1864. *Tudicla elevata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 23.
1868. *Tudicla elevata* Con., Cook's Geol. N. J., p. 730.
1869. *Rapa elevata* Con., Amer. Jour. Conch., vol. 4, p. 248.

1876. *Pyropsis elevata* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 284.

1876. *Pyropsis Richardsoni* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 284.

1883. *Pyropsis perlata* Tryon, Struct. and Syst. Conch., vol. 2, p. 141, pl. 51, fig. 61.

1892. *Pyropsis elevata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 35, pl. 1, figs. 11-13.

1905. *Pyropsis elevata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 23.

1905. *Pyropsis perlata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 23.

(Not *P. richardsoni* or *P. perlata* Whitfield, Pal, N. J., vol. 2 (Monog. U. S. G. S., vol. 18), pp. 37 and 39, pl. 1, figs. 8–10, and pl. 1, figs. 14–16.)

Description.—The dimensions of the type specimen of *P. perlata* are: total height, restored, about 50 mm.; maximum diameter of body volution, 35.5 mm.; approximate length of anterior canal as restored, 26 mm. Shell somewhat pyriform, spire low, the apical angle about 135°. Body volution very wide, the upper surface flat or slightly concave towards the periphery; periphery carinate, the keel uneven, being produced at intervals into low somewhat compressed tubercle-like processes; lower side of the volution convex above, becoming concave below where it is produced rather abruptly into the long anterior canal. Surface of the outer volution marked with revolving costæ, about seven or eight of which, alternating in size, occupy the upper flattened surface; below the periphery and about one-third the height of the body volution, exclusive of the canal below it, is a strong revolving, subcarinate ridge, elevated at intervals into low tubercle-like processes; between this strong rib and the periphery are three costæ, the middle one of which is the stronger, all of which are more or less crenate; below the strong subperipheral rib a series of more or less crenate revolving costæ continue downward to the anterior canal, gradually becoming smaller below. The surface is also marked by more or less conspicuous, transverse lines of growth.

Remarks.—Tuomey's original description of this species is as follows: "Shell top-shaped; spire depressed, almost flat; body whorl angular, terminating suddenly in a canal." In the absence of any illustration it is exceedingly difficult to make any identification from such a meagre definition as this, and more especially when the specimens to be identified are internal casts and the definition a description of the shell itself. Furthermore the whereabouts of the type specimen is not known. The internal casts which Whitfield referred here cannot possibly belong here, however, because the body volution is not in the least angular, although the spire is nearly flat. Judging from the original description, the shell would seem to come very close to the shell described from Tippah County, Miss., by Conrad as *P. perlata,* the type of the genus *Pyropsis*; indeed Conrad himself suggested the identity of the two forms,[1] and Gabb has considered them as identical without any question.[2] Gabb came to this conclusion through a study of numerous specimens of these shells from Mississippi and Alabama, among which was the type of *P. perlata,* and it is reasonable to suppose that he was correct in his conclusion, and his interpretation of the two species will be followed here.

In Whitfield's monograph both the species, *P. perlata* and *P. richardsoni* have been given a place, the specimens upon which both identifications have been made being internal casts. A critical study of both the forms recognized by Whitfield leads to the conclusion that neither of them are really representatives of the southern species under consideration. Indeed, true representatives of *P. richardsoni* seem to be exceedingly rare in the New Jersey faunas, a single individual from the Merchantville clay-marl near Matawan having been observed, and a second specimen from the Navesink marl. The former is a very incomplete internal cast with a portion of the impression of the exterior. A plaster cast taken from this natural mould shows the external features of the shell, so far as they go, of essentially the same character as those of the type of *P.*

[1] Am. Jour. Conch., vol. 4, p. 248.

[2] Proc. Acad. Nat. Sci. Phil. (1876), p. 284.

perlata. The cast itself shows the very flat spire, flatter than any other member of the genus in the New Jersey faunas, and a subangular periphery upon which are indications of irregularities which in the shell itself are tubercle-like processes of the peripheral keel. Conrad[1] has expressed the opinion that *Rapa elevata* is identical with *Pyropsis perlata* Con., and that both may be the same as *P. richardsoni* Tuomey. Gabb,[2] however, says that *R. elevata* certainly is not the same as *P. richardsoni,* although he thinks that *P. richardsoni* and *P. perlata* are the same. Johnson[3] says that *P. elevata* and *P. perlata* "will undoubtedly prove to be the same as *P. richardsonii* Tuomey." Whitfield has considered all three of the species as distinct forms. An examination of the type of *P. elevata* shows that it is certainly identical with *P. richardsoni* and *P. perlata,* as has been previously suggested by Conrad and Johnson; the lithologic characters of the specimen also indicates that it is from the Merchantville clay-marl.

Formation and locality.—Merchantville clay-marl, near Matawan (101); Navesink marl, Atlantic Highlands (108).

Geographic distribution.—New Jersey, Alabama, Georgia, Mississippi.

Pyropsis pyruloidea (Gabb).

Plate LXXXVI., Figs. 6–7.

1860. *Rapa pyruloidea* Gabb, Proc. Acad. Nat. Sci. Phil. (1860), p. 94, pl. 2, fig. 4.
1861. *Rapa pyruloidea* Gabb, Synop. Moll. Cret. Form., p. 130 (74).
1864. *Rapa pyruloidea* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Rapa pyruloidea* ? Con., Cook's Geol. N. J., p. 730.
1892. *Pyrifusus pyruloides* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 53, pl. 4, figs. 12-13.

[1] Am. Jour. Conch., vol. 4, p. 248.
[2] Proc. Acad. Nat. Sci. Phil. (1876)), p. 284.
[3] Proc. Acad. Nat. Sci. Phil. (1905), p. 23.

1905. *Pyrifusus pyruloidea* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 24.

Description.—Shell turbinate, with a very low spire consisting of little more than three volutions, which increase rapidly in size with the growth of the shell, the outer volution comprising the greater bulk of the shell. Aperture very large, subovate in outline except as it is modified on the inner side by the previous volution, widest at the upper third of its height and sharply pointed anteriorly. The columellar cavity in the casts proportionally broad, with no impressions of revolving folds. The surface of the body volution of the casts marked by rather obscure vertical folds on its upper part, seven of which may be counted on the outer half of the volution. The fragment of shell which remains on the specimen is marked by strong, somewhat irregular lines of growth, which are gathered in groups on the upper portion of the volution to form the vertical folds which are visible also in the cast.

Remarks.—This species is a rare one and has not been met with in the recent collections of the Survey, being known only from the type specimen. It seems to be a well-marked species and may be recognized by its low spire and large body volution with the greatest diameter high up and the base pointed. The cast resembles in some degree small individuals of *P. trochiformis,* but it is more elongate. The type specimen seems to show an indefinite revolving line on the outside of the shell about two-thirds of the distance between the suture and the anterior extremity, which is also recognizable upon the cast as a faint, impressed band. The characters of this shell are scarcely consistent with those of the genus *Pyrifusus* where it has been placed by Whitfield, and it is here referred to *Pyropsis* where it seems to be more properly placed, although this generic reference may be incorrect.

Formation and locality.—Navesink marl, Burlington County (Gabb).

Geographic distribution.—New Jersey.

Pyropsis septemlirata Gabb.

Plate LXXXVI., Figs. 8–10; Plate LXXXVIII., Figs. 1–4.

1860. *Cancellaria septemlirata* Gabb, Proc. Acad. Nat. Sci. Phil. (1860), p. 94, pl. 2, fig. 10.

1861. *Cancellaria septemlirata* Gabb, Synop. Moll. Cret. Form., p. 98 (42).

1864. *Cancellaria ? septemlirata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 19.

1868. *Cancellaria (?) septemeirata* Con., Cook's Geol. N. J., p. 729.

1876. *Pyropsis septemlirata* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 285.

1892. *Pyropsis (Rapa ?) septemlirata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 44, pl. 3, figs. 4-8.

1905. *Pyropsis septemlirata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 24.

1892. *Pyropsis (Rapa ?) Corrina* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 45, pl. 3, figs. 1-3.

Description.—The dimensions of a nearly complete internal cast are: height of specimen as preserved, 42 mm.; probable total height, 47 mm.; maximum diameter of the outer volution, 33.5 mm. Shell with about three volutions, the spire low, the suture canaliculate with a wide and deep, subrectangular depression. Outer volution gibbous above, abruptly contracted and produced into a long anterior canal below, the upper half of the gibbous portion much more strongly convex than the lower half. Surface marked by strong revolving costæ or ridges, about eight or ten in number, separated by much broader depressions, the first ridge borders and slightly overhangs the deep sutural depression, the second and perhaps others are somewhat nodose, and all are more or less rugose because of the rather coarse transverse lines of growth. The surface of the internal casts is smooth, with four or five rather obscure revolving angles, and with a broad, sutural cavity.

Remarks.—Casts of this species are not uncommon in the Navesink horizon at Mullica Hill. The characters of the outer

surface of the shell have been determined from plaster casts taken from natural moulds of the shell, of which several incomplete ones have been studied. The species is especially characterized by the strong and deep sutural furrow or fossula, and the strong revolving costæ. A careful comparison of the specimens in the recent collections with Gabb's original examples, the figured type and two others, has shown that their identification is correct. Gabb's specimens were all internal casts, so that the remarkable sutural groove is not shown upon them. The sharply defined collumellar fold, indicated in Gabb's original illustration of the species, does not exist in the specimen. Different individuals of the species vary somewhat in the height of the volutions, but the abrupt contraction to the anterior canal is characteristic. The large individual illustrated by Whitfield is not this species, and is probably not a New Jersey specimen. The internal casts of this species seem to resemble the one illustrated by Whitfield as *P. perlata* more closely than any other, and it is quite possible that that specimen, which certainly is not *P. perlata* Con., may belong to *P. septemlirata*. It differs from most of the specimens chiefly in the greater angularity of the periphery. The exact number of revolving costæ upon the surface of the shell has not been determined with certainty, indeed there is probably some slight variation in the number in different individuals, and in all the specimens observed they seem to have been eroded or otherwise destroyed except towards the aperture.

The type of Whitfield's *P. corrina* seems to be only a rather smooth internal cast of this species, but not smoother than is frequently met with.

Formation and locality.—Navesink marl, Atlantic Highlands (108), Mullica Hill (169), Holmdel (Whitfield).

Geographic distribution.—New Jersey.

Pyropsis planimarginata (Whitfield).

Plate LXXXVI., Figs. 11–14.

1892. *Tudicla planimarginata* Whitf. Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 33, pl. 1, fig. 1-3.

Description.—"Shell small or somewhat below a medium size, very ventricose, with a very low spire composed of but little more than two entire volutions in the cast; outer volution large, forming the great bulk of the shell and having a diameter considerably greater than the entire height, including the short beak and canal. Volutions marked on the periphery by a flattened, vertical band, bordered above and below by an angulation; a second angulation also marking the upper surface midway between the top of the vertical flattening and the suture line, and still another on the under side of the volution near the base of the beak; columellar cavity only of medium size, with aperture large, wider or about as wide as high, but little modified on the inner side by the preceding volution; lip slightly expanded; surface unknown." (Whitfield.)

Remarks.—The flattened bands upon the body of the shell of this species somewhat resemble *Perissolax trivolva* (Gabb), of the Vincentown limesand, but it has a much lower spire of fewer volutions, and it lacks the long anterior canal of that species. The species has not been certainly met with in the recent collections of the Survey. The species should possibly not be separated from *P. septemlirata.*

Formation and locality.—Navesink marl, Crosswicks Creek (Whitfield).

Geographic distribution.—New Jersey.

Pyropsis trochiformis (Tuomey).

Plate LXXXVII., Figs. 1–11.

1854. *Pyrula trochiformis* Tuomey, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 169.

1861. *Tudicla* (*Pyropsis*) *trochiformis* Gabb, Synop. Moll. Cret. Form., p. 141 (85).

1864. *Tudicla trochiformis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 22.

1876. ? *Pyropsis trochiformis* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 285.

1892. *Pyropsis Richardsonii* ? Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 39, pl. 1, figs. 14-16. (Not *P. richardsoni* Tuomey.)

1892. *Pyropsis trochiformis* (?) Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 41, pl. 1, figs. 4-7.
1892. *Pyropsis Reileyi* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 42, pl. 2, figs. 11-20.
1905. *Pyropsis trochiformis* Johns., Proc. Acad. Nat. Sci. Phil (1905), p. 23.

Description.—The dimensions of an incomplete internal cast are: height, as far as preserved, 40 mm.; probable total height, about 60 mm.; maximum diameter, 41 mm. Shell pyriform, with three or four rapidly increasing volutions, spire depressed, the first volution and one-half almost flat in the casts, suture in the cast widely open. Body volution very broad and gibbous, contracting somewhat rapidly below to the anterior canal, which has been broken and destroyed in most of the specimens observed. Surface of the outer volution rounded from the suture to the base of the anterior canal, that portion above the line of greatest width shorter and more strongly convex than that below. Surface of the casts smooth, but sometimes with slight indications of the revolving costæ of the exterior. Columellar cavity large in the casts. External surface of the shell marked by strong, more or less nodose, revolving costæ, and by somewhat irregular lines of growth, the revolving lines becoming gradually more slender towards the base.

Remarks.—The original description of this species is as follows: "Shell top-shaped; body whorl large, inflated, covered with revolving raised lines; spire depressed, not flat; angle of the body whorl rounded; canal produced; aperture nearly circular."

The internal casts which Whitfield has illustrated as representatives of this species are probably correctly identified, with the possible exception of his figure 7, with the strong, revolving ribs near the aperture, although these markings may be due to the immature condition of this particular individual. It is possible that figure 6 of the same author is also incorrectly identified. In addition to these, the specimens which Whitfield has described as *P. reileyi* apparently belong here, and also the internal casts he has identified as *P. richardsoni,* which are totally different from the true *P. richardsoni* of Tuomey. This species, in fact, includes

all those rotund examples of *Pyropsis* which occur in the Navesink marl, the species being distinguished from the associated *P. septemlirata* by their less abrupt contraction below to the anterior canal, and by the absence of the strongly canaliculate suture. These casts of *P. trochiformis,* however, vary somewhat among themselves in the rapidity of their contraction below, in the amount of elevation of the spire, and in the strength of the impressions of the revolving costæ upon the internal casts, but a comparison of many individuals from New Jersey and from southern localities has led to the conclusion that they cannot be specifically divided, at least not in the condition of internal casts, the condition in which they almost invariably occur.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177); Navesink marl, Atlantic Highlands (108), Middletown (113[2]), near Crawfords Corner (126[7]), near Holmdel (128[5], 127), Mullica Hill (169[2]); Tinton beds, Beers Hill cut, south of Keyport (129[9]), Tinton Falls (110).

Geographic distribution.—New Jersey, Alabama, Mississippi.

Pyropsis ? obesa Whitfield.

Plate LXXXVIII., Figs. 5–6.

1892. *Pyropsis ? obessa* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 40, pl. 3, figs. 12-13.

Description.—"Shell of moderate size, very ventricose, with very round, full, short volutions, and short obtuse spire, the body volution being produced below to form a short beak of almost insignificant proportions, as shown by the cast; apical angle about 80 degrees; volutions about three in number, very short and compact; smooth on the surface, except on the last one, where spiral lines are shown to have existed on the shell and to have left their imprint; only about five or six of these traceable, and those on the lower side; aperture moderately large, obliquely ovate, rounded above and pointed below; columella rather strong, somewhat flexuose, judging from the axial cavity left in the cast, and apparently marked by a single, rather prominent oblique ridge in its lower part." (Whitfield.)

Remarks.—This species is evidently not a true *Pyropsis* because of the presence of the columellar fold. Whitfield was not able "to place it satisfactorily under any known genus," at the time he described it, and it may be allowed to remain with a question, where it was placed by the original author.

Formation and locality.—Navesink marl, Mullica Hill (169), (Whitfield).

Geographic distribution.—New Jersey.

Pyropsis retifer (Gabb).

Plate LXXXVIII., Figs. 7–13.

1860. *Fusus retifer* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 301, pl. 48, fig. 11.
1861. *Fusus retifer* Gabb, Synop. Moll. Cret. Form., p. 108 (52).
1864. *Fusus* (?) *retifer* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 22.
1868. *Perissolax retifer* Con., Cook's Geol. N. J., p. 730.
1892. *Pyropsis retifer* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 38, pl. 2, figs. 1-4.
1892. *Dolium* (*Doliopsis* ?) *multiliratum* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 121, pl. 15, figs. 4-6.
1905. *Pyropsis retifer* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 24.

Description.—Shell small, pyriform, or without the anterior canal subglobular in form, the dimensions of a large individual being: height, 22 mm., or probably 25 mm., if the anterior beak were complete; maximum diameter, 18 mm.; height of spire, 6 mm. Volutions about three, rounded, ventricose and rapidly increasing in size, rapidly contracting below to the short anterior beak, spire low, conical, sutures well marked in the cast; aperture large, subcircular on the outer margin, about two-thirds as high as the total height of the shell; columellar cavity in the cast rather narrow. Surface of the casts marked by 8 or 10

spiral ridges upon the body volution, placed at nearly equal intervals, also by fainter vertical ridges which appear usually to have been placed at nearly equal intervals to those of the spiral ridges, though occasionally they are somewhat closer. Upon the external surface, as shown in impressions of the outside, the revolving and vertical ribs are much more conspicuous than on the casts, their intersections being marked by small, rounded nodes.

Remarks.—This is a well-marked species and can be easily recognized. It most resembles *P. octolirata,* but the summit of the outer volutions adjacent to the suture is less flattened, and the outer volution is marked by a larger number of revolving costæ which are crossed by transverse costæ at more frequent intervals. In the recent collections of the Survey the species has been found to be common in the Wenonah sand at one locality, and one of Whitfield's specimens came from the same horizon. It also occurs in the Navesink marl.

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]), near Middletown (Whitfield); Navesink marl, near Red Bank (120), Crosswicks Creek (147[4]), near Walnford (Whitfield).

Geographic distribution.—New Jersey.

Pyropsis whitfieldi n. sp.

Plate LXXXVIII., Figs. 14–16.

1892. *Pyropsis octolirata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 36, pl. 2, figs. 8-9, not fig. 10. (Not *P. octolirata* Conrad.)

Description.—Shell small, subglobular or subpyriform in form, with about three, ventricose, rapidly expanding volutions; the dimensions of a nearly complete internal cast being: height, 19.5 mm., which might be increased to 25 mm. if the anterior canal were complete; maximum diameter, 16 mm.; height of spire, 5.5 mm. Spire low-conical, volutions distinctly flattened adjacent to the suture, marked by from six to nine spiral ridges or costæ

upon the casts, which are crossed by vertical ridges at about equal intervals or slightly more distant than the spiral lines, the two sets of markings dividing the surface into a number of square, depressed spaces; anterior beak short, apparently straight, and rather pointed; aperture elongate, pointed above and below, about half as wide as long. In the casts the suture is distinct and often strongly marked.

Remarks.—This species is of about the same size as *P. retifer,* from which it may be distinguished by the distinctly flattened band on the upper side of the volutions adjacent to the suture; the spire is also slightly more depressed, and the lower side of the outer volution contracts a little more rapidly to the anterior beak. The species has only been seen in the condition of internal casts, and by Whitfield was referred to *P. octolirata.* It differs from *P. octolirata,* however, in the presence of vertical ribs, and apparently also in the flattening of the upper margin of the volutions.

Formation and locality.—Navesink marl, Crosswicks Creek (195), near Walnford (Coll. N. J. Geol. Surv.).

Geographic distribution.—New Jersey, Alabama.

Pyropsis octolirata (Conrad).

Plate LXXXVIII., Figs. 17–18.

1858. *Ficus octoliratus* Con., Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 332, pl. 35, fig. 6.
1861. *Perissolax octolirata* Gabb, Synop. Moll. Cret. Form., p. 123 (67).
1864. *Perissolax octolyrata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 23.
1868. *Perissolax octolirata* Con., Cook's Geol. N. J., p. 730.

Description.—Shell pyriform or, exclusive of the anterior canal, subglobular in form, consisting of three or four volutions, the outer one of which is produced in front in an elongate anterior canal; imperforate; suture slightly impressed; the dimensions of a somewhat incomplete internal cast are: total height, 20 mm.; height of spire, 4 mm.; maximum diameter of outer volution,

about 14 mm. Outer volution regularly rounding from the suture to the base of the anterior canal, marked by eight or nine spiral ribs, one of which on the upper side, about half way between the periphery and the suture, is slightly nodose, the strongest costæ are those upon and just below the periphery; on the upper side, between the nodose rib and the suture, is a single faint rib. On the internal cast the revolving ribs are much fainter than upon the shell itself, and the nodes of the uppermost costa are not shown.

Remarks.—This species resembles *P. whitfieldi,* but it may be distinguished from that species by the absence of the rather distinct flattening of the volutions adjacent to the suture, by the total absence of vertical ribs, and by the more elongate anterior beak. The type of *P. octolirata* Conrad has apparently been destroyed or lost. The very meager description given by the author of the species is as follows: "Pyriform; spire conical; costæ of body volution about eight in number, inclined to be square, distant; beak long and slender." The illustration accompanying the original description is poor, but it shows a shell totally lacking in vertical ribs and without a distinct flattening of the volutions just below the suture. Whitfield has referred certain examples to the species which have distinct vertical ribs and a flattened revolving band just below the suture, which are evidently distinct and have been described in this report as a new species, *P. whitfieldi.* The only specimen in the New Jersey collections which seems to agree with Conrad's original definition of the species is the one here described and illustrated from the Woodbury clay at Lorillard.

Formation and locality.—Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey, Mississippi.

Pyropsis lenolensis n. sp.

Plate LXXXVIII., Figs. 20–24.

Description.—Shell small and, exclusive of the anterior beak, subglobular in form, with about four volutions; the dimensions of a nearly complete individual are: height, 13 mm.; probable height, if anterior beak were complete, 18 mm.; maximum diameter, 11.5 mm.; height of spire, 4 mm. The volutions distinctly

flattened above in a spiral band just below the suture, the outer margin of the flattened band being elevated in a moderately strong revolving rib, below this rib the outer volution is nearly regularly convex to the base of the anterior canal which is rather elongate and slender; surface of the outer volution marked by about six or seven strong, revolving ribs between the outer margin of the flattened band above and the base of the anterior beak, the outer half of the volution being also marked by several, rather strong, vertical varices which are about twice as far apart as the revolving ribs, these varices do not cross the flattened band above, and at their junction with the revolving ribs they are elevated into rounded nodes; entire surface of the shell also marked by somewhat irregular, transverse lines of growth. On the internal casts the transverse varices are well marked, but the revolving ribs are faint except at the junction with the varices; the columellar cavity narrow.

Remarks.—This species most closely resembles *P. whitfieldi,* but, besides being confined to an entirely different geologic horizon, the flattened upper margin is more distinct, the vertical markings are more remote varices in the outer half of the last volution of the adult shells rather than regular ribs covering the entire shell with a distance apart about equaling the spaces between the revolving ribs. Furthermore, the vertical varices in *P. lenolensis* end at the outer margin of the upper flattened spiral band, while in *P. whitfieldi* the ribs apparently continue to the suture, judging from the internal casts alone.

Formation and locality.—Merchantville clay-marl, Lenola (163).

Geographic distribution.—New Jersey.

Genus EUTHRIA Gray.

Euthria ? fragilis Whitfield.

Plate LXXXVIII., Figs. 25–26.

1892. *Euthria ? fragilis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 78, pl. 9, figs. 11–12.

1905. *Euthria ? Fragilis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 23.

Description.—"Shell small, measuring only about three-fourths of an inch in length; form short fusiform, the point of greatest diameter being nearly midway of the length; spire short, the apical angle taken from a crushed example, being about 70°, probably not more than 60° to 65° in perfect specimens; volutions ventricose, six or seven in number, the last one forming the great bulk of the shell and with the anterior beak forming about five-sevenths of the entire length when measured on the back of the volution; upper volutions compact; sutures strongly marked; anterior beak short, moderately strong; aperture not seen; substance of the shell very thin and fragile, marked only by fine lines of growth parallel to the margin of the aperture, which indicate the existence of a broad and rather marked sinus in the lip on the upper side of the volution, formed by the extension of the lip below and on the body of the volution far in advance of the margin at and just below the suture; on the surface of the beak the striæ gently inclined backward again." (Whitfield).

Remarks.—The type specimen of this species is the only example which has been observed. It is a very fragile shell and is somewhat crushed and distorted. Its generic characters are not clearly shown, and it is not with any certainty a member of the genus in which Whitfield has placed it. However, the species may be allowed to remain where its original author placed it until additional specimens are found which will throw more light upon its true relationships.

Formation and locality.—Woodbury clay, near Haddonfield (183).

Geographic distribution.—New Jersey.

Family PURPURIDAE.

Genus RAPANA Schumacher.

Rapana stantoni n. sp.

Plate LXXXIX., Figs. 1–3.

Description.—Shell subpyriform, with a large, vertically corrugated umbilicus; the dimensions of the type specimen are:

height of shell, 24 mm.; maximum diameter, 25 mm.; height of aperture, 12 mm.; width of aperture, 11 mm. Volutions about three and one-half or four in number, the spire depressed, the suture ill-defined; the anterior portion of the shell rather abruptly contracted from the body of the shell. Aperture subcircular, slightly higher than wide, with a very narrow anterior canal; the outer lip with a rather thick, slightly undulating margin, inner lip rather thick. Surface of the outer volution marked by seven strong, revolving ribs separated by somewhat wider, rounded furrows, with an eighth less conspicuous one upon the anterior, canaliculate portion; the first three of these ribs, next to the suture, occupy the upper surface of the volution, the interval between the first and second being somewhat greater than between the other ribs; the revolving ribs are crossed by strong vertical folds at somewhat variable intervals, but which are usually a little more distant than the revolving ribs; at the points where the vertical and revolving ribs cross, the surface of the shell is elevated in conspicuous nodes; surface also marked by fine, more or less irregular lines of growth.

Remarks.—The type of this species is a nearly perfect example from the Ripley formation at Chatfield, Navarro County, Texas, No. 21070 of the invertebrate paleontological collection of the U. S. National Museum. In New Jersey a single imperfect individual has been observed.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177).

Geographic distribution.—New Jersey, Texas.

Family FUSIDAE.

Genus Fusus Lamark.

Fusus holmesianus Gabb.

Plate LXXXIX., Fig. 4.

1860. *Fusus Holmesianus* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 389, pl. 68, fig. 4.

1864. *Fusus Holmesianus* Meek, Check List, Inv. Foss. N. A., Cret. and Jur., p. 22.

Description.—The dimensions of the figured specimen are: height, 15 mm.; height of spire, 4 mm.; greatest diameter, 8 mm.; apical angle, 60°. Shell fusiform with about three or four volutions, spire conical and turrited, the outer volution produced below into a straight anterior canal of moderate length. Suture moderately distinct; upper surface of the volutions flattened or a little concave, sloping downward from the suture to the line of greatest diameter, which is marked with a row of about 14 or 15 vertically elongate nodes upon each volution; on the volutions of the spire these nodes originate at about the middle and continue downward to the suture below, which is flexuose on account of the projection of the nodes; on the body volution the surface below the row of nodes is gently convex above, becoming concave below as it passes into the anterior canal. Entire surface of the shell marked with fine revolving lines.

Remarks.—The New Jersey examples of this species have been compared with Gabb's type of the species, and they seem to be identical in all essential specific characteristics.

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey, Alabama.

Fusus cliffwoodensis n. sp.

Plate LXXXIX., Figs. 6–7.

Description.—The dimensions of the type specimen are: height, 18.5 mm.; height of spire, 5.5 mm.; greatest diameter, 10 mm.; apical angle, 75°. Shell fusiform with about four volutions, suture fairly well defined, outer volution produced below into a short, anterior canal. Outer volution flattened above, the upper surface short, sloping slightly downward from the suture to the periphery; below the periphery the slope is long and gently convex, becoming concave below as it passes into the anterior canal; periphery marked with about 12 or 14 strong nodes, which are much elongate anteriorly, reaching about half way from the periphery to the extremity of the anterior canal.

Volutions of the spire not well preserved in the type specimen, but they are apparently angular at about their mid-height and are marked with nodes similar to those on the periphery of the outer volution. Aperture narrowly subovate, pointed below, more than twice as high as wide. Surface of the shell apparently smooth, or marked only with inconspicuous lines of growth.

Remarks.—This species closely resembles *F. holmesianus* Gabb, but the nodes upon the shoulder of the outer volution are larger and more elongate, and all spiral markings are lacking.

Formation and locality.—Cliffwood clay, near Matawan (107).

Geographic distribution.—New Jersey.

Fusus holmdelensis Whitfield.

Plate LXXXIX., Figs. 11–12.

1892. *Fusus ? Holmdelensis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 62, pl. 6, figs. 10–11.

Description.—"Shell of moderate size, about 1½ inches in length; spire short, less than one-third as long as the body volution and beak; volutions four or more, the upper ones rather small and the body volution proportionally large, ventricose in the middle and extended in front in a moderately long, slightly twisted canal; aperture large, more than half the entire length of the shell; the outer lip broadly and strongly sinuate in the upper part and somewhat extended forward below; columella slender, twisted; surface of the volutions marked by rather strong, prominent, vertical folds, which are most distinct on the body of the lower whorl, but become obsolete below, and on the upper whorls are extended from suture to suture, 10 of these folds being visible on the large volution; strong lines of growth also cross the shell parallel to the border of the aperture; closely arranged, elevated spiral lines cover the entire shell, and are finest and most numerous on the upper part, more distant below the middle, and strongly marked on the anterior beak, where they are very oblique; the spaces between the lines apparently flat." (Whitfield.)

Remarks.—The type specimen is the only individual of this species which has been seen, and it forms an exception to most of the gastropods of the Navesink marl, in that the form of the shell itself is preserved. The internal cast of the species has not been recognized.

Formation and locality.—Navesink marl, Holmdel (Whitfield).

Geographic distribution.—New Jersey.

Fusus lorillardensis n. sp.

Plate LXXXIX., Figs. 9–10.

Description.—The dimensions of the type specimen are: height, 53 mm.; height of spire, 23 mm.; greatest diameter, 18 mm.; apical angle about 34°. Shell elongate-fusiform, with six or seven volutions, the outer volution produced into an elongate anterior canal; suture moderately impressed; the surface of the volutions of the spire regularly convex from suture to suture. Surface of the shell marked by a revolving ridge or shoulder of moderate size just below the suture; each volution marked by from 15 to 18, or less upon the smaller volutions, rather sharp, elevated, vertical, slightly curved ridges, the concave side of the curve towards the aperture; on the volutions of the spire the ridges continue from suture to suture but on the outer volution they become obsolete a little less than half way from the suture to the anterior extremity of the canal; surface also marked by fine revolving costæ, three or four of which occupy the space of one millimeter, and by distinct transverse lines of growth which have a broad but slight sinuosity below the suture, following the direction of the transverse ridges.

Remarks.—This shell somewhat closely resembles *F.* (*Exilifusus*) *kerri* Gabb, from North Carolina,[1] but it is less slender with a less extended anterior canal, giving to the spire a relatively greater height. The type is a partial internal cast with the nearly complete external mould, from which a plaster cast has been taken. The transverse ribs are clearly visible on the internal cast, but they are broadly rounded and much lower than on the shell itself.

[1] Proc. Acad. Nat. Sci. Phil. (1876), p. 279, pl. 17, fig. 1.

The dimensions given are of the largest individual observed, but numerous smaller specimens have been collected.

Formation and locality.—Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey.

Genus CRYPTORHYTIS Meek.

Cryptorhytis obliquicostata Gabb.

Plate LXXXIX., Fig. 8.

1876. *Fasciolaria* (*Cryptorhytis*) *obliquicostata* Gabb, Proc. Acad. Nat. Sci. Phil. (1876). p. 283.

Description.—The approximate dimensions of an imperfect specimen are: height of shell when complete, point of spire restored, 12.5 mm.; height of spire, about 4 mm.; greatest diameter, 7 mm.; apical angle, about 52°. Shell fusiform with about three or four volutions, suture well defined, outer volution produced below into a rather short anterior canal. Surface of the volutions of the spire convex from suture to suture, and marked by a series of elongate, slightly oblique, rather sharp nodes, about 11 or 12 on each volution, which originate close to the upper suture, become strongest at about the mid-height of the volution and grow fainter below to the lower suture. Upon the outer volution the nodes resemble those of the spire and become obsolete below, about half way between the suture and the extremity of the anterior canal; the surface of the outer volution is convex from the suture to below the middle where it becomes concave as it passes into the anterior canal, the periphery being without a distinct angulation. Surface of the shell marked throughout with fine revolving lines.

Remarks.—This species is represented in the collections from New Jersey by very few imperfect examples in which the most essential characters are not shown. These examples have been compared with the type of the species, however, and the two seem to agree in such characters as are shown on both specimens, and the identification is probably correct.

Formation and locality.—Woodbury clay, Lorillard (102), near Haddonfield (165).

Geographic distribution.—New Jersey, North Carolina.

Genus SERRIFUSUS Meek.

Serrifusus nodocarinatus Whitfield.

Plate LXXXIX., Fig. 13.

1892. *Serrifusus (Lirofusus) nodocarinatus* Whitf., Pal. N. J., vol. 2, (Monog. U. S. G. S., vol. 18), p. 64, pl. 5, figs. 22–23.

Description.—"Shell of medium size, abruptly fusiform in general outline; spire broad conical, the height from the broadest part of the body volution being somewhat less than the diameter at its periphery; beak short, slender; volutions three or four (the specimen being imperfect), somewhat bicarinate in the middle where there is a nearly vertical, obliquely flattened area or band, above which the surface slopes rapidly to the suture and is very slightly concave; below this point the volution contracts very abruptly to the short, slender canal, leaving the body volution somewhat compressed-discoidal or wheel-like in form, which in the specimen is possibly exaggerated by vertical crushing; periphery of the volutions marked by rather strong, transverse node-like vertical folds, which are also continued in less strength above and below, and the entire surface is occupied by spiral ridges of considerable strength, but which alternate in size on the lower part of the volution; four or five of these revolving ridges occupy the upper side; about three mark the vertical space of the periphery, and seven or more may be counted on the lower side of the body volution, in the poorly preserved specimen used; aperture not seen." (Whitfield.)

Remarks.—This is a rare form, which, so far as known, is represented only by the type specimen described by Whitfield.

Formation and locality.—Navesink marl, Marlboro (Whitfield.)

Geographic distribution.—New Jersey.

Serrifusus crosswickensis Whitfield.

Plate LXXXIX., Figs. 14–17.

1892. *Serrifusus ? Crosswickensis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 63, pl. 5, figs. 24–25.

Description.—"Shell small or of medium size, biturbinate in form, shorter below than above the middle, exclusive of the beak, the extension of which is unknown, casts only having been observed; spire broadly conical, the apical angle measuring about 55°; volutions about four and a half or five on the internal cast; angularly ventricose, vertical or concave on the periphery, the latter character particularly a feature of the body volution; upper side of the volutions obliquely sloping, the slope being somewhat greater than the angle of the spire, so as to reveal the vertical portion of each volution; lower side rounded; aperture nearly as broad as high, as seen in a transverse section, the outer lip slightly biangular, corresponding to the narrow vertical band of the periphery; columella strong, indicating a rather robust beak; surface features unknown." (Whitfield.)

Remarks.—This species is an uncommon form in the Navesink marl fauna, only a single specimen, aside from the type, having come under the observation of the writer. Both these specimens are internal casts, so the external characters of the shell are wholly unknown.

Formation and locality.—Navesink marl, Atlantic Highlands (108), Crosswicks Creek (Whitfield).

Geographic distribution.—New Jersey.

Genus Odontofusus Whitfield.

Odontofusus medians Whitfield.

Plate XC., Figs. 1–6.

1892. *Odontofusus medians* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 67, pl. 5, figs. 18–21.

1892. *Pyrifusus turritus* Whitf., Pal. N. J., vol 2 (Monog. U. S. G. S., vol. 18), p. 54, pl. 5, fig. 4 (not figs. 1–3).

1905. *Pyrifusus turritus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 24 (in part).

Description.—Shell fusiform with seven or eight volutions, produced below into a rather slender, straight, anterior canal, spire slender, about four-fifths as high as the aperture; the dimensions of a nearly complete shell from the Ripley formation of Mississippi are: total height, 36.5 mm.; height of spire, 17 mm.; maximum diameter of shell, 15 mm.; apical angle, 48° to 50°. Outer volution somewhat ventricose above and contracted below into the anterior canal. Just below the suture the shell is marked by a rather narrow, crenulated, revolving band, below which the volutions expand somewhat abruptly; shell marked by strong vertical folds, about 12 of which occupy the outer volution. These folds are slightly oblique and are somewhat curved, the concave side being directed towards the aperture, they become obsolete below the middle of the outer volution, the lower canaliculate portion of the shell being marked by rather fine revolving ribs. Aperture elongate, rounded above, pointed below; outer lip thin, columella marked by a single revolving fold, which is situated high up, and so far back that it can scarcely be seen from the aperture in complete examples of the shell.

Remarks.—The above description of the shell of this species has been made from a nearly complete example from the Ripley formation of Mississippi, No. 20490, of the invertebrate paleontological collection of the National Museum at Washington. The New Jersey examples, including the type of the species, are all internal casts. They have the same general form as the shell described, but the volutions are not preserved to the apex of the spire, the vertical folds are not so strong, the revolving ribs of the lower portion of the outer volution are absent, or very faintly marked, and the columellar fold shows as a groove. The species is intermediate in its characters between *O. typicus* and *O. mucronata*. It differs from the former in being less abruptly contracted below to the anterior canal, and from the latter in being more robust and less slender. The columellar

cavity in the casts is more slender in this species than in either of the others. Sometimes a second faint, revolving fold is present upon the columella, situated above the primary one.

The three specimens which Whitfield has illustrated as the types of his *Pyrifusus turritus* apparently belong to three different species of as many different genera. One of the specimens, probably the best of the three, preserved in the collection of the Philadelphia Academy of Science, has been shown, upon cleaning out the columellar cavity, to have a distinct columellar fold, and the specimen differs in no essential manner from the type of *Odontofusus medians*.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (180); Navesink marl, Atlantic Highlands (108), Crosswicks Creek (149, 195).

Geographic distribution.—New Jersey, Mississippi.

Odontofusus typicus Whitfield.

Plate XC., Figs. 7–16.

1892. *Odontofusus typicus* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 66, pl. 6, figs. 1-5.

Description.—"Shell when of full size about 2 inches long in the extreme, so far as yet known; spire elevated, forming about one-half of the entire length of the shell, which contains about four and one-half to five volutions in the condition of internal cast; volutions angular, rather strongly so in the principal one, forming an angulated periphery which is crossed by 10 or 12 prominent, vertical ridges, which generally show as transverse nodes on the periphery and only extend a short distance above or below, apparently never reaching to the suture line; lower portion of the body volution extended so as to form a rather slender anterior beak, about equaling in length the vertical diameter of the body volution, as seen from the dorsal side; aperture moderately large, angular at the middle of the outer lip and extended below in a narrow canal; columella marked by a single, rather strong, oblique fold, situated near the middle of the aperture proper;

very faint indications of spiral striæ may be imagined on the cast, but can scarcely be said to exist." (Whitfield.)

Remarks.—As this species usually occurs, the anterior beak is more or less injured, often being broken off close up to the body of the outer volution. Even the original specimen of Whitfield's figure 5, showing the extended anterior canal, no longer preserves that portion of the shell, it having been injured apparently since the figure was drawn. The specimens observed vary somewhat in the number of nodes present, Whitfield gives the number as 10 or 12, but about nine seems to be a commoner number. The abrupt contraction of the lower side of the outer volution to the base of the anterior canal, and the single rather strong revolving fold upon the columella are characteristic features of the shell. One internal cast preserves a series of impressions of crenulations along the lower half of the aperture at distances of about one mm. apart, which only extend back from the aperture for a space of two or three millimeters. One specimen from Mullica Hill which preserves the greater portion of the shell is apparently a member of this species. The shell is rather thick, the nodes are sharper and much more pronounced than on the casts, and the entire surface is marked by distinct, rather coarse revolving costæ a little over one millimeter apart.

Formation and locality.—Navesink marl, near Crawfords Corner (126[7]), Crosswicks Creek (149, 195), Mullica Hill (169[2]), Cream Ridge (Whitfield).

Geographic distribution.—New Jersey.

Odontofusus mucronata (Gabb).

Plate XCV., Figs. 5–11.

1861. *Voluta mucronata* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 323.
1864. *Voluta mucronata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Volutilithes mucronata* Con., Cook's Geol. N. J., p. 730.
1876. *Volutomorpha mucronata* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 293.

1892. *Odontofusus rostellaroides* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol 18), p. 68, pl. 6, figs. 6-7.

1892. *Volutomorpha* (*Piestochilus*) *mucronata* Whitf., Pal. N. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 75, pl. 6, figs. 12-14.

1905. *Volutomorpha mucronata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 25.

Description.—"Shell, as exhibited in the casts, slender, with an elevated and slender spire and prolonged rostral beak, giving an elongate, fusiform outline; volutions five or more, moderately convex and with strongly marked suture lines; body volution, as seen from the front, forming considerably more than half of the length of the entire shell, and the aperture two-thirds as long as the body volution; elliptical in outline, angular above and prolonged below; columella slender, marked by two very oblique folds, which are situated somewhat below the middle of its length, the lower being much the stronger of the two; surface features unknown. There is the slightest evidence on two individuals of distant longitudinal folds on the second volution, but not sufficiently distinct to give grounds for a positive assertion that such characters existed." (Whitfield.)

Remarks.—This species was originally described by Gabb as a member of the genus *Voluta* and was later referred to the genus *Volutomorpha* by the same author, under which name, with the subgeneric designation *Piestochilus,* it was described by Whitfield. Whitfield also described in the same report a new species *Odontofusus rostellaroides.* A careful study of the types of both these species, as well as numerous other specimens, has led to the conclusion that they are all members of a single specific group. The two genera, *Odontofusus* and *Piestochilus* are much alike in their general characters when seen only in the condition of internal casts. Both are more or less fusiform shells with usually a single rather strong columellar fold, though sometimes one or two other and usually fainter folds are developed. The primary difference between the two genera seems to be in the presence or absence of vertical folds upon the shell. With the shells them-

selves preserved this would be an easy means of identifying the two genera, but in these internal casts the folds are often very faintly shown. All the specimens of the species under discussion, however, which have been observed, have indications of these vertical folds, and they were also mentioned in the original description of the species by Gabb. Consequently the species is here placed in the genus *Odontofusus*.

Formation and locality.—Navesink marl, near Crawfords Corner (126[7]), Middletown (113[2]), Crosswicks Creek (195), Freehold, Holmdel (Whitfield).

Geographic distribution.—New Jersey.

Odontofusus slacki (Gabb).

Plate XC., Fig. 17.

1861. *Fasciolaria Slackii* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 322.
1864. *Fasciolaria Slackii* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Fasciolaria Slackii* Con., Cook's Geol. N. J., p. 730.
1876. *Fasciolaria Slackii* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 282.
1892. *Odontofusus Slacki* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 66, pl. 6, figs. 8–9.
1905. *Odontofusus slackii* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 24.

Description.—"Shell, as shown by internal casts, slender, fusiform, nearly of equal length above and below the point of greatest diameter of the body whorl; spire slender, apical angle about 35° to 40°; volutions five or six (none of the specimens are perfect to the apex); angular in the middle and slightly convex above and below, the last one increasing more rapidly than those above; sutures distinct and deep; anterior end prolonged into a straight, moderately slender canal; columella strong, marked by a single oblique, well defined ridge or fold at about the middle or above the middle of its length; aperture

pyriform, largest above and angular at the middle of the outer lip corresponding to the angulation of the body whorl; volutions marked by distant, angular, vertical folds or ridges, seven to nine of which may be counted on a single volution; these folds are indicated very strongly on the center of the volution in the cast, but not visible to any great extent much above or below; no positive indications of spiral lines have been seen on any of the casts." (Whitfield.)

Remarks.—A careful examination of the lithologic characters of the type specimen of this species has led to the decision that it is certainly from the Merchantville clay-marl, the formation from which alone the species has been met with in the recent collections of the Survey. The species is closely allied to *O. medians,* the similarity being almost too close to admit of specific differentiation, the chief difference being the more slender form of *O. slacki.*

Formation and locality.—Merchantville clay-marl, Lenola (163), Merchantville (162), Crosswicks (Gabb).

Geographic distribution.—New Jersey.

Genus Turbinella Lamark.

Turbinella intermedia n. sp.

Plate XC., Figs. 18–22.

Description.—Internal casts short fusiform to subglobular in form, with about three volutions, the dimensions of two nearly complete examples being: height, 18 mm. and 13 mm.; greatest diameter, 17 mm. and 11.8 mm. Apical angle about 75°, the spire about one-third the total height of the shell, the volutions increasing somewhat rapidly in size, subangular on the periphery and marked by rather strong vertical nodes, which become obsolete before reaching the suture above, and also a short distance below the periphery, about 12 nodes occurring upon the outer volution; the last volution rather rapidly contracting below and produced into a short anterior beak; columellar cavity of moderate width, bearing the impressions of three rather faint revolving folds.

Remarks.—Only the internal casts of this species have been observed. These resemble similar casts of *T. alabamensis,* but they are always shorter, with the volutions less regularly rounded over the periphery, and they do not attain so large a size. They differ from the casts of *T. parva* in being somewhat larger, in having a more elevated spire and in the more nearly vertical position of the nodes. The species is, in fact, somewhat intermediate in its characters between *T. alabamensis* and *T. parva,* and has been observed only from the Merchantville clay-marl, while these other two species are both Navesink species.

Formation and locality.—Merchantville clay-marl, Lenola (163).

Geographic distribution.—New Jersey.

Turbinella alabamensis (Gabb).

Plate XCI., Figs. 1–6.

1860. *Cancellaria Alabamensis* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 301, pl. 48, fig. 14 (fig. 26 on plate).

1861. *Cancellaria Alabamensis* Gabb, Synop. Moll. Cret. Form., p. 98 (42).

1861. *Turbinopsis Alabamensis* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 321.

1864. *Turbinopsis* (?) *alabamensis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 19.

1892. *Turbinella ? verticalis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 82, pl. 3, figs. 14–15.

1905. *Pyropsis alabamensis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 24.

Description.—Internal casts, exclusive of the anterior canal, subglobose in form, with a moderately elevated spire, which has an apical angle of about 85°, consisting of about three and one-half volutions; the dimensions of a nearly complete internal cast are: height, 36 mm.; height of spire, 9 mm.; greatest diameter, 26 mm. Volutions increasing rather rapidly in

size, the last one ventricose in the upper part, rapidly contracted below and produced anteriorly in an elongate anterior canal; aperture elliptical in form, pointed above and prolonged below; columellar cavity of moderate size, with three slender, oblique plications opposite the middle of the aperture; surface of the volutions marked by strong, rounded, vertical plications or folds, which become obsolete a little below the periphery and are also less distinct upon the outer half of the last volution. About 11 of these folds are present upon the outer volution of an average example. A plaster cast of the upper half of a shell from a natural mould has about five volutions, the spire is conical and turrited with an apical angle of about 75°; suture well defined; the volutions of the spire strongly angular a little below the middle of the distance between the sutures, the upper surface flattened or slightly concave, the angle marked with strong nodes, of which there are about 12 on each volution. Upper surface of the body volution nearly flat, sloping downward from the suture to the angular periphery, which is marked by strong nodes similar to those of the upper volutions; below the periphery the surface is gently convex as far as the specimen continues. Surface marked by fine revolving costæ, and by lines of growth which, just below the suture, are as strong or stronger than the revolving costæ. The direction of the lines of growth indicate that the outer lip of the aperture was broadly sinuate in its upper part.

Remarks.—The specimen used by Whitfield as the type of his *Turbinella verticalis* has been carefully compared with the type of *Cancellaria alabamensis* Gabb, and the two are certainly specifically identical. The species is not an uncommon one in the Navesink marl, where it has been seen only in the form of internal casts. The external characters of the shell have been determined, so far as they are known, from a plaster cast taken from a natural mould collected in the Wenonah sand, the internal cast of the same example being also preserved, although in a somewhat imperfect condition. This internal cast, however, shows that the Wenonah specimen is not specifically different from the Navesink shells.

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]), near Marlboro (130[1]); Navesink marl, near Crawfords Corner (126[7]), Mullica Hill (169), Atlantic Highlands (108), Crosswicks Creek (147[4]).

Geographic distribution.—New Jersey, Alabama.

Turbinella parva Gabb.

Plate XC., Figs. 23–24.

1860. *Turbinella parva* Gabb, Proc. Acad. Nat. Sci. Phil. (1860), p. 94, pl. 2, fig. 3.
1861. *Turbinella parva* Gabb, Synop. Moll. Cret. Form., p. 142 (86).
1864. *Turbinella parva* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Turbinella parva* Con., Cook's Geol. N. J., p. 730.
1892. *Turbinella ? parva* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 80, pl. 9, figs. 4–6.
1905. *Turbinella parva* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 25.

Description.—Shell small, subturbinate in form, the greatest diameter being near the top of the volution, rapidly narrowing below, spire depressed, but not quite flat; the dimensions of an incomplete internal cast are: height, 11.5 mm., but if the spire were complete anteriorly it would probably be 13 mm. or 14 mm.; maximum diameter, 14 mm. Volutions about three in number, flattened above, rounded on the periphery; aperture large, oblique, higher than wide; columellar cavity in the casts broad, marked by three distinct plications or folds, the two upper ones a little above the lower third of the aperture, equal in strength and near together, the lowest one larger and more distant, but not so sharply defined as those above; volutions marked by sinuous vertical folds of considerable strength, indicated on the top of the volution, but more strongly marked on the periphery and below, being strongly bent backward in crossing the largest part of the whorl.

Remarks.—This species is known only from internal casts, and, so far as known, is restricted to the fauna of the Navesink marl. It differs from both *T. alabamensis* and *T. intermedia* in its much more depressed spire.

Formation and locality.—Navesink marl, near Atlantic Highlands (108), Crawfords Corner (126[7]), near Holmdel (127), Crosswicks Creek (195).

Geographic distribution.—New Jersey.

Turbinella subconica Gabb.

Plate XCI., Figs. 11–12.

1860. *Turbinella subconica* Gabb, Proc. Acad. Nat. Sci. Phil. (1860), p. 94, pl. 2, fig. 6.
1861. *Turbinella subconica* Gabb, Synop. Moll. Cret. Form., p. 142 (86).
1864. *Turbinella subconica* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Turbinella ? subconica* Con., Cook's Geol. N. J., p. 730.
1892. *Turbinella ? subconica* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 81, pl. 9, figs. 7-8.
1905. *Turbinella subconica* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 25.

Description.—"Shell rather below a medium size, the cast measuring only about 1 inch in height, with a transverse diameter somewhat less; form turbinate, with a very low spire, consisting of not more than three volutions in the only specimen known; volutions ventricose, obconical, scarcely rounded on the upper margin, but rapidly narrowing below and rounded on the side; aperture large, almost semilunate, or only very slightly convex on the inner margin; columella strong, marked by two very distinct plications at the lower third of the aperture, the lower one being distinctly the stronger of the two; sutures between the whorls of the cast very large, indicating a thick, heavy shell; surface as shown on the inside of the body whorl of the cast marked by strong spiral lines

or ridges, and by remarkably strong vertical folds, numbering 12 or 13 on the last volution, and transmitting their features only very slightly to the internal cast at the point of greatest diameter, but showing on the inside as above stated for more than half its depth." (Whitfield.)

Remarks.—This species has not been met with in the recent collections of the Survey, and seems to be known only from the single type specimen used by both Gabb and Whitfield in their descriptions.

Formation and locality.—Navesink marl, Monmouth County (Gabb).

Geographic distribution.—New Jersey.

Genus CARICELLA Conrad.

Caricella plicata Whitfield.

Plate XCI., Figs. 7–8.

1892. *Caricella plicata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 182, pl. 23, figs. 1–2.

Description.—"Shell small, turbinate or pyriform, with a short, broadly conical spire having an apical angle of about 85°. Volutions four or more, not exceeding five, the apical one mammillated; upper surface sloping in the direction of the spire, slightly angulated at the point of greatest diameter and the lower extremity slightly attenuated; body of the volution ventricose; aperture large, nearly three-fourths the length of the shell, oblique and somewhat elliptical in general form, canaliculate below. Columella slight, as shown by the cavity left by its removal, marked by four very distinct, oblique, equi-distant folds, the upper one of which is situated nearly at the middle of the length of the aperture. Body volution marked in the cast by about 12 very oblique vertical folds, which are directed very strongly forward in passing from above downward, but are confined entirely to the region of the angle near the top of the volution. No positive evidence of other surface markings can be detected on the casts." (Whitfield.)

Remarks.—This species has not been met with in the recent collections of the Survey, but the species is a well-marked one and cannot be easily mistaken. In some respects the species is intermediate in its characters between *Caricella* and *Voluta*, the vertical folds upon the periphery of the shell being like the latter genus, while the character of the folds of the columella are like the former genus.

Formation and locality.—Manasquan marl, Farmingdale (Whitfield).

Geographic distribution.—New Jersey.

Genus VASUM Bolten.

Vasum conoides Whitfield.

Plate XC., Figs. 9–10.

1892. *Vasum conoides* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 83, pl. 9, figs. 9–10.

Description.—"Shell rather small, regularly conoidal above and below the point of greatest diameter, which is at the upper edge of the body volution; spire longer than the shell below, as seen from the back of the volution; and very evenly and gradually diminishing; number of volutions unknown but apparently numerous; apical angle about 35°; aperture elongate, narrow, becoming pointed below, the length as given by projecting the spire of the shell to an imaginary apex is rather less than one-third as long as the entire length of the shell; columella moderately strong, marked by three proportionally strong folds and indications of a smaller fourth one very near the base; surface of the cast perfectly smooth, with the exception of a broad sulcus marking its surface on the last volution, at about one-third of the distance below the upper edge, indicating either a thickening of the inside of the shell or a sinuosity in the outer lip." (Whitfield.)

Remarks.—This species has not been recently collected, and it seems to be known only from the type specimen. In the

absence of the external characters of the shell, the generic position of the species is somewhat doubtful, but it may be allowed to remain, for the present, where originally placed by Whitfield. The shell has much the appearance of the upper volutions of a species of *Rostellites*.

Formation and locality.—Navesink marl, near Walnford (Whitfield).

Geographic distribution.—New Jersey.

Family VOLUTIDAE.

Genus VOLUTODERMA Gabb.

Volutoderma woolmani Whitfield.

Plate XCI., Figs. 18–19.

1893. *Volutoderma Woolmani* Whitf., The Nautilus, vol. 7, pp. 37 and 51, pl. 2, figs. 4–5.
1905. *Volutoderma woolmani* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 25.

Description.—"Shell, as shown by the internal cast, somewhat more than an inch in length, and having a diameter of the body volution of seven-sixteenths of an inch in the cast, being more slender than any species yet described. Volutions largest just below the suture and attenuate below, forming a moderately long beak; marked in the upper part by eight comparatively strong vertical plications, which are obsolete below. Columella marked by three very distinct folds or ridges, the lowest of which is the strongest. These are well marked on the inside of the upper volutions." (Whitfield.)

Remarks.—This species is a very distinct one, and differs from other members of the genus in the New Jersey faunas in its smaller size and more slender form.

Formation and locality.—Merchantville clay-marl, Lenola (163).

Geographic distribution.—New Jersey.

Volutoderma biplicata (Gabb).

Plate XCI., Figs. 13–17.

1860. *Volutilithes biplicata* Gabb, Jour. Acad. Nat. Sci. Phil, 2d ser., vol. 4, p. 300, pl. 48, fig. 6.
1861. *Volutilithes biplicata* Gabb, Synop. Moll. Cret. Form., p. 149 (93).
1864. *Rostellites biplicata* Meek, Check List. Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Rostellites biplicatus* Con., Cook's Geol. N. J., p. 729.
1876. *Volutoderma biplicata* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 292.
1892. *Volutoderma biplicata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 90, pl. 10, figs. 1–2.
1905. *Volutoderma biplicata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 25.

Description.—"Shell of medium size, robust, pyriform in outline, with a low spire and very large body volution; whorls three to four, ventricose, largest above the middle and narrowed below; aperture very large, elongate, two-thirds the length of the shell and semielliptical, straightened on the inner side and rounded on the outer margin; columella strong, marked by two strong oblique folds near the middle of its length; surface unknown, but on the inner volution of the type and on a smaller specimen in the collection Am. Mus. Nat. Hist., N. Y. City, there are a few distant vertical plications, faintly indicated, but which do not extend below the most ventricose part of the whorl." (Whitfield.)

Remarks.—A careful examination of the lithologic characters of the type of this species has led to the conclusion that it came originally from the Merchantville clay-marl. In the recent collections of the Survey it has been observed most commonly in the Merchantville, but it also occurs rarely in the Wenonah sand.

Formation and locality.—Merchantville clay-marl, Lenola (163); Woodbury clay, near Matawan (103); Marshalltown

clay-marl, near Swedesboro (177); Wenonah sand, near Crawfords Corner (126[3]).

Geographic distribution.—New Jersey.

Volutoderma ovata Whitfield.

Plate XCI., Figs. 20–21.

1892. *Volutoderma ovata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 91, pl. 10, figs. 3–4.

Description.—"Shell below a medium size, subovate in general outline, being large above the middle of the length and attenuated toward the base; spire short; its apical angle nearly 90° on the internal casts, with strong, rounded volutions and very deep, strongly marked sutures; body volution proportionally large, forming nearly the bulk of the cast; greatest diameter a little below the shoulder and rapidly diminishing below; aperture large, nearly straight on the inner margin, strongly rounded above on the outer margin, and gently curved along the lower two-thirds of the length; columella proportionally strong, leaving a large cavity on removal, as seen in the cast; marked by two strong, very oblique plications or folds above the middle of its length, the upper one of which is much the smaller; volutions marked by distant vertical folds only faintly seen on the cast, and only on the upper portions when visible; on the inner surface of the cast, between the volutions, the vertical plications are strongly marked, as in all the species of the genus yet observed; but I have not seen any remains of spiral lines as on most of them, still, I presume they have existed." (Whitfield).

Remarks.—This species differs from *V. biplicata* in having the greatest diameter of the outer volution higher up, so that the shell contracts less rapidly below. The shell closely resembles *Volutomorpha gabbi* Whitf., and it seems scarcely possible that the two should be referred to different genera, as Whitfield has done, although he seems to have considered the two forms to be cogeneric at the time he wrote his description of

the species. The two species differ in the number of columellar folds, *V. gabbi* having only one, while *V. ovata* has two.

Formation and locality.—Navesink marl, Atlantic Highlands (108), Crosswicks Creek (195), Mullica Hill (Whitfield).

Geographic distribution.—New Jersey.

Volutoderma jamesburgensis n. sp.

Plate XCI., Figs. 22–23.

Description.—Shell of medium size, the dimensions of the type specimen being: height, 30 mm.; maximum diameter, 17 mm. Volutions about four in number, the spire of moderate height, apical angle about 58°. Suture well defined; just below the suture is a rounded ridge marked by conspicuous oblique costæ about one millimeter apart on the outer volution; just below this ridge is a narrow, concave band, outside of which, upon the shoulder of the volution, is a series of strong rounded nodes about three mm. apart from center to center on the outer volution, which continue longitudinally as strong, rounded ribs to the anterior extremity of the shell. Surface also marked by fine, vertical lines of growth; revolving lines entirely absent. The internal cast is similar in general form, the suture is well defined, the volutions are flattened above, or even slightly concave, towards the aperture, sloping downward to the line of maximum diameter beneath the row of strong nodes on the exterior, below which the sides are nearly vertical to the suture below, or in the body volution becoming concave towards the anterior extremity. The vertical ribs are shown on the internal casts, but are much weaker than upon the exterior of the shell.

Remarks.—This species is based upon a natural mould of the exterior of the shell with the internal cast of the same individual. It is one of the few individuals of this genus from the Cretaceous formations of New Jersey whose external characters are known to any considerable degree.

Formation and locality.—Merchantville clay-marl, near Jamesburg (140).

Geographic distribution.—New Jersey.

Volutoderma abbotti (Gabb).

Plate XCII., Figs. 1–2.

1860. *Volutilithes Abbotti* Gabb, Proc. Acad. Nat. Sci. Phil. (1860), p. 94, pl. 2, fig. 7.

1861. *Volutilithes Abbotti* Gabb, Synop. Moll. Cret. Form., p. 149 (93).

1864. *Volutilithes* (?) *Abbotti* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.

1868. *Volutilithes* (?) *Abbotti* Con., Cook's Geol. N. J., p. 729.

1876. *Volutomorpha Abbotti* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 293.

1892. *Volutoderma Abbotti* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 173, pl. 21, figs. 4–9.

1905. *Volutoderma abbotti* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 25.

Description.—"Shell of medium size, elongately oval in general outline, with a very short spire and large body volution which forms nearly the entire bulk of the shell, and which is nearly evenly convex above and below the middle. Volutions about four in number; suture line not very distinct. Aperture long and narrow, rather more than two-thirds as long as the shell and pointed above and below. Columella comparatively strong, marked by three or four very oblique folds of moderate strength. Surface of the shell unknown, all the specimens recognized being internal casts." (Whitfield.)

Remarks.—There seems to be some doubt as to the proper horizon of this species. Gabb described it from "Burlington Co., N. J.," which allows a very wide range of horizons from which it might have come. Whitfield states that the lithologic character of the specimens indicate that they are from the Timber Creek beds, which would make their horizon Vincentown. The shell resembles *V. biplicata,* but is much more slender and the columella is furnished with a larger number of folds, there being only two in *V. biplicata,* while in this species there are three or four.

Formation and locality.—Uncertain.

Geographic distribution.—New Jersey.

Volutoderma intermedia Whitfield.

Plate XCII., Fig. 3.

1892. *Volutoderma intermedia* Whitf., Pal. N. J., vol. 2 Monog. U. S. G. S., vol. 18), p. 184, pl. 23, figs. 14–15.

1905. *Volutoderma intermedia* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 25.

Description.—"Shell of medium size, elongate ovate in outline, with a moderately elevated spire and ventricose volutions, the last one of which forms the greater bulk of the shell and is most ventricose above the middle. Volutions three to four in number and rapidly increasing in size. Aperture semilunate, oblique, nearly straight on the inner side, forming a little more than half of the entire length of the shell as shown in the cast. Columella marked by two or three strong, oblique, nearly equidistant plications; outer surface of the shell unknown. The inner surface of the volutions in one of the casts, which would preserve the markings of the volution within it where any existed, is entirely smooth, indicating a smooth shell; but another fragment, which appears to belong to the species, has the surface closely lirated with markings of numerous vertical folds which have formed nodes at the junction of the two sets. It also shows three columellar folds, as does the smooth one. The last one has been an old shell, much thickened, as indicated by the great space between the coils of the cast, while the other which bears the markings has been smaller and very much thinner in substance. So we may readily suppose that the shell possessed both sets of markings in its perfect condition." (Whitfield.)

Remarks.—This species has not been met with in the recent collections of the Survey. It differs from both *V. biplicata* and *V. abbottii* in the greater height of its spire; in the ventricosity of its outer volution it approaches more closely to the former, but in the number of folds upon the columella it resembles the latter.

Formation and locality.—Manasquan marl, near Vincentown (Whitfield).

Geographic distribution.—New Jersey.

Genus VOLUTOMORPHA Gabb.

Volutomorpha conradi (Gabb).

Plate XCII., Figs. 6–7; Plate XCIII., Figs. 1–3; Plate XCIV., Figs. 1–6.

1860. *Volutilithes Conradi* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 300, pl. 48, fig. 10.
1861. *Volutilithes Conradii* Gabb, Synop. Moll. Cret. Form., p. 149 (93).
1861. *Fulguraria Conradi* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 364.
1864. *Rostellites Conradi* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Rostellites Conradi* Con., Cook's Geol. N. J., p. 730.
1876. *Volutomorpha Conradi* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 293.
1883. *Volutomorpha Conradi* Tryon, Struct. and Syst. Conch., vol. 2, p. 166, pl. 54, fig. 27.
1892. *Volutomorpha conradi* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 71, pl. 6, fig. 21; pl. 7, figs. 1–3, 4, 5 ?.
1892. *Volutomorpha Gabbi* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 73, pl. 7, fig. 6; pl. 8, figs. 1–4.
1905. *Volutomorpha conradi* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 25.
1905. *Volutomorpha gabbi* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 25.

Description.—"Shell large, some specimens apparently attaining a length of 4½ inches, with a diameter of the largest volution of rather more than 1¼ inches; spire short, or only moderately elevated, although the general form of the shell is somewhat slender, the body volution, as viewed on the apertural side, forms fully four-fifths of the entire length, even in the condition of internal casts; upper volutions compact, convex on the sides, and rather squarish or suddenly rounded to the suture on the top; body volution very large and very gracefully swollen

or convex in the upper part, and prolonged and attenuated below, forming a long, gracefully tapered anterior beak with the columella slightly twisted; top of the volution rather suddenly contracted to the suture; aperture large, very elongate-elliptical in outline and prolonged below, where it becomes narrowed as the outer lip approaches the axis; columella slightly twisted and marked by from one to three very oblique folds, the middle one of which is usually the strongest; surface of the casts usually smooth, with the exception of, in some cases only, a few distant vertical folds on the upper ones, and on the extreme upper part of the body volution; but where the external features are preserved, the whole shell is marked by strong, rounded, vertical folds, and but little less strongly marked, rounded, spiral ridges; the spiral ridges moderately distant on the upper part of the volution, but becoming less strongly marked and crowded, and finally almost obsolete, toward the base." (Whitfield.)

Remarks.—More or less imperfect casts of this species are not infrequently met with in collections from the Navesink marl of New Jersey. A careful comparison of the types of the two species *V. conradi* and *V. gabbi,* shows the two forms to be too closely alike to be regarded as specifically different. The separation of the two supposed specific forms by Whitfield was based almost entirely upon the more robust form and the squarer shoulder of *V. gabbi,* but an examination of numerous examples, all from the same horizon, shows the two forms to be only extreme individual variations of a common species.

Formation and locality.—Cliffwood clay, Cliffwood Point (103); Navesink marl, Atlantic Highlands (108), near Freehold (133), near Walnford (148^2) Crosswicks Creek (147^4), near Jacobstown (150), near Mount Laurel (166), Mullica Hill (169^2), Holmdel (Whitfield).

Geographic distribution.—New Jersey.

Volutomorpha ponderosa Whitfield.

Plate XCV., Figs. 1–2.

1892. *Volutomorpha ponderosa* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 72, pl. 8, figs. 5–6; pl. 9, figs. 13–15.

Description.—"Shell large and moderately ventricose, attaining a length of 7 or more inches, with a transverse diameter of nearly or quite 2¼ inches; spire moderately elevated, with depressed convex whorls; volutions five or more, the last one forming nearly or quite three-fifths of the entire length, gently convex throughout the upper three-fourths of its length and slightly narrowed and extended in front; aperture long elliptical, acute above and narrowed in front; sutures between volutions only moderate; surface, as seen on casts, usually smooth, but sometimes showing both vertical and spiral ridges, while on the surfaces between the volutions of the casts very distinct vertical and spiral ridges appear. On one of the larger individuals the columellar lip appears to have been considerably thickened, and to have been but very faintly marked by a single fold, very obliquely placed; while on the upper portion of its surface the ridges of the preceding volution have left their imprint, appearing as nearly horizontal folds, though in reality being the effect of external markings. The single very oblique fold is placed very near the base of the columella, and on some specimens appears only as an angulation of the columella." (Whitfield.)

Remarks.—This species is probably the largest gastropod in the Cretaceous faunas of New Jersey. It resembles *V. conradi,* but it is much more ponderous than that species, with a less-extended anterior beak. The volutions of the spire are also proportionally much longer and less ventricose than in that species, and none of the volutions are shouldered at the top.

Formation and locality.—Navesink marl, Cream Ridge, Holmdel, Freehold, eastern Monmouth County (Whitfield).

Geographic distribution.—New Jersey.

Genus PIESTOCHILUS Meek.

Piestochilus bella (Gabb).

Plate XCVI., Figs. 1-4. Plate XCII., Figs. 4-5.

1860. *Volutilithes bella* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 300, pl. 48, fig. 7.

1861. *Volutilithes bella* Gabb, Synop. Moll. Cret. Form., p 149 (93).
1861. *Fulguraria bella* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 364.
1864. *Rostellites bella* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Rostellites bellus* Con., Cook's Geol. N. J., p. 729.
1876. *Volutomorpha bella* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 293.
1892. *Volutomorpha* (*Piestochilus*) *bella* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 74, pl. 6, figs. 15–18.
1905. *Volutomorpha bella* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 25.

Description.—"Shell, as shown by the cast, elongate, fusiform and slender, with moderately full volutions and distinct suture lines; spire short, the body volution as viewed from the front forming from three-fourths to four-fifths of the entire length, and the narrow, anteriorly prolonged aperture more than one-half of the length; volutions four or more in number, the last one most ventricose above the middle of its length and narrowed and prolonged below; columella showing two strong oblique folds at about the middle of the aperture; surface unknown." (Whitfield.)

Remarks.—In the original description of this species it was said to come from the "Delaware and Chesapeake Canal," but the type specimen in the collection of the Philadelphia Academy of Science is labeled in Gabb's handwriting "Cret. N. J." In the recent collections of the Survey no specimens have been met with which can be referred to this species. If the type specimen came from New Jersey, the lithologic character would indicate that it was from the Navesink marl.

Formation and locality.—Navesink marl, ? Monmouth County.

Geographic distribution.—New Jersey.

Piestochilus kanei Gabb.

Plate XCVI., Figs. 5–9.

1861. *Voluta Kanei* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 323.
1864. *Voluta Kanei* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Voluta ? Kanei* Con., Cook's Geol. N. J., p. 730.
1876. *Volutomorpha Kanei* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 293.
1892. *Volutomorpha (Piestochilus) Kanei* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 76, pl. 6, figs. 19-20.
1905. *Volutomorpha kanei* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 25.

Description.—"Shell small, short elliptical in outline, with a short pointed spire and proportionally long body volution; volutions probably about four, ventricose, largest above the middle and attenuate below; aperture large, elongate elliptical, widest above the middle and narrow below. Columella moderately strong, marked by two distinct and distant plications below the middle of the aperture; surface of the shell so far as can be seen on the inside of the cast of the outer volution in one of the type specimens, marked by a few spiral ridges and by distant vertical plications or folds, but which are not transmitted to the internal cast in any of the individuals seen." (Whitfield.)

Remarks.—Internal casts from several horizons have been referred to this species with more or less doubt, and the true relationships of these various forms can never be properly determined until the external features of the shells are better understood. One internal cast from the Cliffwood clay (pl. xcvi. fig. 7) has the form of this species but with evidence of but a single columellar fold. It is accompanied by an impression of a small portion of the exterior of the shell which shows that there was a slight thickening of the outer volution at least, just beneath the suture forming a very narrow revolving shoulder be-

low which there was a narrow, revolving concave band and then a row of rather broad, low and short, somewhat obscure nodes. Other casts from the Wenonah sand (pl. xcvi, figs. 5-6) have but a single slight columellar fold and approach somewhat in their general form the illustrations of *P. bella,* but differ from that species in their lower volutions and consequent shorter spire. All the shells of this genus have characters which seem to ally them to some of the forms referred to *Odontofusus,* and further material in a more satisfactory condition of preservation than has yet been obtained, is highly desirable and indeed absolutely necessary, in order to make clear our understanding of these forms.

Formation and locality.—Cliffwood clay ?, Cliffwood Point (185); Wenonah sand ?, near Crawfords Corner (126[3]); Navesink marl, Crosswicks Creek (Whitfield).

Genus Rostellites Conrad.

Rostellites texturatus Whitfield.

Plate XCVI., Figs. 12–13.

1868. *Rostellites Texanus* Con., Cook's Geol. N. J., p. 730. (Not *R. texanus* Conrad, 1855.)

1892. *Rostellites texturatus* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 88, pl. 11, figs. 5–6.

Description.—"Shell rather large, very elongate, elliptical in outline, pointed at each extremity, spire very short, conical, with scarcely convex volutions, three to four in number; body volution large forming about six-sevenths of the entire length, very gently convex throughout its entire length, except near the anterior end, where it becomes very slightly recurved; aperture very large, but narrow, acute above and below; columellar plaits unknown; surface of the shell marked by spiral ridges and by vertical lines; the former much the stronger and alternating in size where preserved sufficiently well to show; the vertical lines cut the spiral ridges so as to break them into nodes on the outer shell." (Whitfield.)

Remarks.—This species differs from *R. nasutus* and *R. angulatus* especially in the proportionally shorter spire, in the more symmetrical body volution, and in the greater strength of the markings of the shell. In general it seems to be more characteristic of the Merchantville clay, while the others occur most commonly in the Navesink marl.

Formation and locality.—Merchantville clay-marl, Lenola (163); Navesink marl, Holmdel (Whitfield).

Geographic distribution.—New Jersey, Alabama, Mississippi.

Rostellites nasutus Gabb.

Plate XCVII., Figs. 1–2.

1860. *Volutilithes nasuta* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 300, pl. 48, fig. 9.
1861. *Volutilithes nasuta* Gabb, Synop. Moll. Cret. Form., p. 150 (94).
1861. *Fulguraria nasuta* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 364.
1864. *Rostellites nasuta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 21.
1868. *Rostellites nasutus* Con., Cook's Geol. N. J., p. 730.
1876. *Rostellites nasutus* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 294.
1892. *Rostellites nasutus* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 86, pl. 11, figs. 1-2.
1905. *Rostellites nasutus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 25.

Description.—"Shell of moderately large size, sometimes attaining a length of nearly or quite 5 inches. Form slender, with a proportionally short, turreted spire, varying from two-thirds of the length of the body volution in the casts to not more than one-third in the shell itself; number of volutions uncertain, the type specimen having had about four; body volution slender, most ventricose near the upper part, marked by numerous spiral ridges with broader interspaces which have possibly been marked

by smaller ridges between the large ones; the upper lines nearly parallel to the suture, but below they become more and more oblique, so that the lower ones become nearly parallel with the columella; aperture comparatively broad and the lip thin; columella marked by three or four very oblique folds, situated near the middle of its length; the upper three at equal distances from each other and the lower one a little more distant from the next above." (Whitfield.)

Remarks.—This is the common member of the genus in the fauna of the Navesink marl in New Jersey. The specimens are almost always more or less fragmentary, so that the complete form of the shell is rarely preserved. It is altogether probable that the specimen described by Whitfield as a distinct species under the name *R. angulatus,* is only a form of the more common *R. nasutus,* and it is quite possible that both of them are the same as *R. texanus* Conrad.

Formation and locality.—Merchantville clay-marl, Lenola (163); Navesink marl, Middletown (113^2), near Crawfords Corner (126^7), near Holmdel (128^5, 127), Crosswicks Creek (195), Freehold, Marlboro (Whitfield).

Geographic distribution.—New Jersey.

Rostellites angulatus Whitfield.

Plate XCVII., Figs. 3–4.

1892. *Rostellites angulatus* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 88, pl. 11, figs. 3-4.

1905. *Rostellites angulatus* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 25.

Description.—"Shell moderately large and proportionally slender, with an elevated spire, as shown by the cast, the only condition in which it has been recognized; body volution forming the great bulk of the shell, and the aperture equaling more than one-half of the entire length; volutions probably five or more, flattened on their surfaces with abrupt scalariform sutures; last volution flattened or obscurely concave below the suture for

nearly one-half the length, and abruptly contracted below, forming an undefined angle a little above the middle of the length of the volution, and extended below into a more or less slender columella; aperture narrow and pointed above, broad and somewhat effuse below; columella marked by four strong oblique folds, the lower one of which is more distant from the next above than are the others from each other; surface features unknown." (Whitfield.)

Formation and locality.—Navesink marl, Atlantic Highlands (108).

Geographic distribution.—New Jersey.

Rostellites biconicus Whitfield.

Plate XCVII., Figs. 5–8.

1892. *Rostellites biconicus* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 183, pl. 23, figs. 10-11.

Description.—"Shell moderately elongated, as seen in the conditions of internal casts, the only condition in which it is at present known. Spire elevated, consisting of about four or five volutions, the aperture, which is narrow, forming about two-fifths of the length of the entire cast. Volutions moderately convex, largest at or near the upper margin, indicating something of a square, shoulder-like upper surface for the perfect shell; below this angulation the upper volutions are slightly convex, and in the casts leaving very deep and strong sutures between the different whorls of the spire. Lower volution distinctly largest above and cone-like in shape, with a short columellar projection below; the lower half of the volution being more rapidly tapering than the upper, forms a slight angulation just below the middle. Columella strong and marked by four nearly equidistant oblique folds, the lower one of which is not more than once and a half as far from the base as the distance between each fold. Aperture very narrow, pointed above and below; surface, as far as can be seen on the internal casts, showing no evidence of longitudinal folds or revolving lines; but the shell having been quite thick may not

have preserved such features on the interior surface." (Whitfield.)

Remarks.—This species may be easily distinguished from *R. nasutus* by reason of its proportionally more elongate spire, that portion of the shell usually being about one-half its total length, while in *R. nasutus* the spire is much shorter than the body volution. This species is usually much smaller than *R. nasutus*, the specimen illustrated by Whitfield being one of the largest examples seen. In the smaller shells the upper margin of the volutions is usually not so square and shoulder-like as in Whitfield's large individual, and the shell approaches *Volutoderma intermedia* in form, but it is always more slender than that species, and has four strong columellar folds.

Formation and locality.—Manasquan marl, near Farmingdale (138), Squankum (Whitfield).

Geographic distribution.—New Jersey.

Genus TURRICULA Klein.

Turricula scalariformis Whitfield.

Plate XCVII., Fig. 11.

1892. *Turricula scalariformis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 95, pl. 11, fig. 9.

Description.—"Shell greatly elongated, the spire being proportionally slender and composed of numerous volutions, which are moderately convex, and moderately increasing in height with additional growth; number unknown; the specimen consists only of a portion of the spire containing about five volutions, the apex and body volution being absent; surface marked by strong vertical folds which are separated by concave, equally wide depressions, quite straight and ridged in their direction from suture to suture, and number about 16 to each volution; folds crossed by spiral lines, about eight of which can be counted on the exposed part of the volutions, and raised and rounded on the top." (Whitfield.)

Remarks.—This species differs from *T. reileyi* and *T. leda* in its more convex volutions and its stronger vertical folds which are not flexuose between the sutures. The only known specimen is the type which is much crushed and imperfect. In his illustration of the specimen Whitfield has made the revolving lines to appear much stronger than they really are in the specimen.

Formation and locality.—Navesink marl, Holmdel (Whitfield).

Geographic distribution.—New Jersey.

Turricula leda Whitfield.

Plate XCVII., Fig. 9.

1892. *Turricula leda* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 93, pl. 11, fig. 7.

Description.—"Shell fusiform, with a moderately elevated and turreted spire, the apical angle of which is somewhat less than 30°; volutions five or six in number, flattened in the direction of the spire, or very little convex on the surface, and bordered on the lower margins in the cast by a distinct band, which forms about one-third of the height; body volution proportionally rather more convex in the middle than the others and constricted below, forming a beak of moderate length; the height of this volution as seen from the back of the outer lip forms, with the beak, rather more than one-half of the entire length of the shell; shell marked throughout by distinct vertical ridges or folds, more numerous and more closely arranged on the body whorl than on those above, except perhaps the apical ones, and have a slight backward curvature in the middle in passing from suture to suture; the shell also marked by spiral ridges which, on the body volution, are of nearly equal strength with the vertical folds, but are invisible on the other volutions in the specimens used." (Whitfield.)

Remarks.—This species differs from *T. reileyi* in its less slender form and its proportionally shorter spire with a smaller

number of volutions, and in the coarser surface markings. It has not been met with in the recent collections, and like *T. reileyi* is known only from the single type specimen.

Formation and locality.—Navesink marl, Freehold (Whitfield).

Geographic distribution.—New Jersey.

Turricula reileyi Whitfield.

Plate XCVII., Fig. 10.

1892. *Turricula Reileyi* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 92, pl. 11, fig. 8.

Description.—"Shell slender, extremely elongated, turreted; spire very much elevated and slender; whorls numerous, slightly convex on the surface and very distinctly banded on their lower margin; body volution proportionally more convex than the others, being swollen near the middle of its length; attenuate and rostrate below, and nearly or quite one-half the length of the shell as seen from the outside of the aperture; sutures very distinct, bordered by a broad band which is very distinctly separated from the other part of the volution by an impressed line nearly or quite as deep and distinctly marked as the suture line itself; surface of the shell marked by numerous vertical folds, with slightly concave spaces between; the folds are narrow and distinct, and very slightly bent backward in the middle of their length in their passage across the volution, but not interrupted perceptibly at the line separating the band from the body of the volution, and become obsolete on the rostrated part of the last one. Besides the vertical folds, the entire shell is marked by sharp, closely arranged spiral lines, which are finer and more numerous on the upper part, becoming more distant and stronger below, especially on the lower part of the last volution, where they seem to have alternated with finer intermediate striæ. This latter feature may be only apparent, however, as the condition of the specimens is not such as entirely to establish this feature as a character of the shell. The crossing of the vertical folds by

the spiral striæ in the upper volutions produces a very decided and beautifully cancellated structure." (Whitfield.)

Remarks.—This species has not been met with in the recent collections of the Survey, and in fact is known only from the single type specimen.

Formation and locality.—Navesink marl, Freehold (Whitfield).

Geographic distribution.—New Jersey.

Super-family TOXOGLOSSA.

Family CANCELLARIIDAE.

Genus CANCELLARIA Lamark.

Cancellaria subalta Conrad.

Plate XCVIII., Fig. 1.

1869. *Cancellaria subalta* Con., Am. Jour. Conch., vol. 5, p. 100, pl. 9, fig. 22.

1892. *Cancellaria* (*merica*) *subalta* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 95, pl. 12, figs. 24–25.

1905. *Cancellaria subalta* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 26.

Description.—"Shell small, slender or elongate-fusiform, with an elevated spire composed of moderately convex volutions, which may have been, as the author says, six in number; sutures quite distinct; body volution proportionally large, forming considerably more than half the length of the shell; aperture rather large, obliquely elliptical with the outer side more rounded than the inner; acute above and apparently so below; outer lip strongly crenulate within; inner lip coated with a deposit, but not sufficiently heavy to conceal the surface markings of the shell beneath it, which show through and present somewhat the appearance of plaits; axis apparently slightly perforated; surface marked by strong and deep vertical and spiral grooves with

sharp ridges between, which produce aspirate nodes by their intersection; 11 or 12 of the longitudinal ridges may be counted on the inner half of the last volution and six of the spiral ridges above the top of the aperture. The upper two or three volutions appear to have been smooth, or nearly so, as originally described." (Whitfield.)

Columella marked by two well-defined revolving folds below the mid-height of the aperture.

Remarks.—This is one of the very characteristic species of the Woodbury clay, although a single individual has been found in the Merchantville clay. It is a rather common species at Lorillard, but like so many of the members of the fauna at this locality, it grows to a larger size than at Haddonfield, the locality from which the species was originally described. Whitfield's illustration of the type specimen is about two and one-half times enlarged, the specimen itself being about 8.5 mm. in height. The Lorillard specimens are frequently 12 mm. in height, and the largest ones are nearly 20 mm. It is a beautiful little shell and is always easily recognized by its reticulate surface markings, which are usually preserved in great perfection in the moulds of the exterior of the shell.

Formation and locality.—Merchantville clay-marl, near Matawan (101); Woodbury clay, Lorillard (102), near Matawan (103), Crosswicks (168), near Haddonfield (164, 183).

Geographic distribution.—New Jersey.

Cancellaria smocki n. sp.

Plate XCVIII., Figs. 2–3.

Description.—Shell with about three volutions in the cast; the dimensions of two of the type specimens are: height, 18.5 mm. and 15.5 mm.; maximum diameter, 12 mm. and 10 mm.; height of aperture, 12 mm. and 9.5 mm. The upper surface of the volutions is nearly horizontal adjacent to the suture, but the sides round rapidly downward becoming nearly parallel with the axis of the shell at about one-fourth the distance from the suture to the anterior margin of the outer volution, from this

point the surface is gently convex to a point about two-thirds the distance from the suture to the anterior margin, below which it contracts rather abruptly to the umbilical margin; the shell is not produced into an anterior canal. In the casts the umbilical cavity is narrow, indicating an imperforate or a very narrowly perforate shell, columella marked by three faint revolving folds situated below the middle of the inner lip of the aperture. Surface of the shell as seen in impressions of the exterior, marked by rather strong, regular transverse ribs which curve backward from the suture until they cross the somewhat rounded shoulder of the shell, below which they are nearly vertical; about 20 to 22 of these ribs occupy the larger volutions, but they do not cross the lower contracted portion of the outer volution; surface also marked by narrow, raised, revolving lines, six or eight of which occupy the nearly vertical surface of the outer volution and the volutions of the spire, with the vertical ribs dividing that surface of the shell into depressed, quadrangular spaces; about six similar revolving lines are also present upon the lower contracting portion of the outer volution, continuing to the umbilical margin, all the revolving lines exhibit some tendency to alternate in size.

Remarks.—This species differs from *C. subalta*, with which it is associated, in its much more robust form and in its larger size.

Formation and locality.—Merchantville clay-marl, near Matawan (101); Woodbury clay, Lorillard (102), near Matawan (103).

Geographic distribution.—New Jersey.

Genus Turbinopsis Conrad.

Turbinopsis depressa Gabb.

Plate XCVIII., Figs. 6–11.

1861. *Turbinopsis depressa* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 321.

1864. *Turbinopsis depressus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 19.

1868. *Turbinopsis depressus* Con., Cook's Geol. N. J., p. 729.
1905. *Turbinopsis depressa* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 26.
1892. *Modulus lapidosa* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 152, pl. 17, figs 6-8.
1905. *Turbinopsis lapidosa* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 26.

Description.—The dimensions of one of the specimens, an internal cast, are: height, 14 mm.; maximum diameter of the outer volution, 14 mm. Shell broadly umbilicate, with two or three volutions, spire depressed, suture about flush with the surface. Outer volution gibbous, its greatest width above the middle, periphery rounded, the upper and lower surfaces both convex, the slope of the upper surface to the suture more abrupt than the slope of the lower surface, contracted below to a very short anterior canal. Surface of the outer volution marked with revolving costæ, probably about seven or eight in number, and by transverse ribs of about equal strength, with interspaces about equal to those between the revolving costæ; the points of intersection of the revolving and transverse ribs are elevated into low nodes. Internal casts smooth or marked by more or less indistinct revolving ribs, the surface rounded from the suture to the angular umbilical margin, the greatest thickness of the volution about its mid-height; columellar cavity very broad, marked by a single strong and sharp revolving fold situated near the anterior margin.

Remarks.—This species usually occurs in the condition of internal casts, but at one locality in the Wenonah sand impressions of the exterior have been collected which show the character of the external surface markings of the shell. There seems to be no essential difference between the shell which Whitfield described as *Modulus lapidosus* and the type of *Turbinopsis depressus*. Whitfield's specimen exhibits the revolving ribs upon the cast somewhat more clearly, and the spire is a little more depressed than Gabb's type, but these differences can be considered as nothing greater than individual varieties, certainly not of specific importance.

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]); Navesink marl, near Walnford (148[2]).

Geographic distribution.—New Jersey.

Turbinopsis angulata Whitfield.

Plate XCVIII., Figs. 12–13.

1892. *Turbinopsis angulata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 101, pl. 12, figs. 17-18.

1905. *Turbinopsis angulata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 26.

Description.—"Shell rather above the usual size, short conical, and rather obese in general form, oblique as seen from the back; composed of two and a half or three volutions, which increase somewhat rapidly in size with increased growth; apical angle about 70°; volutions ventricose, obliquely flattened on the upper side and obtusely round-pointed below, with a quite distinct angulation at the upper third, or just above the upper third of the length, as seen on the last one, and a less distinct one below the middle, dividing the body volution into three sections, of which the middle one is rather broader than the others and imperceptibly flattened; above the body volution the whorls are marked by about eight vertical folds, or angulations representing folds, which do not extend to the suture line on the cast, the only condition in which it has been observed; aperture elongate ovate, largest below; columellar cavity in the cast of medium size, marked at the base by a distinct groove, indicating the presence of a tooth-like ridge on the shell, showing the generic position of the species; the surface has also been marked by spiral lines or ridges, 15 or more in number, on the last whorl near the lip, very perceptible on the surface between the whorls in the cast." (Whitfield.)

Formation and locality.—Navesink marl, Crosswicks (Whitfield).

Geographic distribution.—New Jersey.

Turbinopsis ? elevata Whitfield.

Plate LXXXIII., Figs. 14–15.

1902. *Turbinopsis elevata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 102, pl. 12, figs. 13–14 (not figs. 10–12).

1905. *Turbinopsis elevata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 26.

Description.—"Shell of moderately small size as indicated by internal casts only; spire elevated, consisting of but few whorls, which in the casts are widely disconnected, indicating a thick shell or whorls disconnected in the shell itself, which is most probable; volutions convex, rounded above and on the periphery, but compressed and wedge-form below; aperture elongate-ovate, rounded above, but wedge-shaped below; umbilical opening, in the cast, quite large, smooth, not showing any indication of the spiral tooth-like ridge; surface of the cast showing rather distant vertical folds, but very little indication of spiral striæ, the shell being probably too thick for them to be transmitted to the cast." (Whitfield.)

Remarks.—This species and the closely-allied *T. curta* have been among the most puzzling of the gastropod shells in New Jersey collections, in regard to their generic relations. The species are only known from internal casts, which, of course, makes their generic reference the more difficult. The essential characters common to both are the broad columellar cavity which undoubtedly indicates an umbilicate shell, the absence of columellar folds, and the more or less distinct vertical plications of the shell. It seems impossible to refer them to *Turbinopsis* where they are placed by Whitfield on account of the entire absence of columellar folds, the members of that genus being characterized by one strong fold upon the columella situated very low down. In their essential characters these species seem to agree with some of the shells referred to *Pyrifusus* by Whitfield, especially *P. mullicaensis* and *P. macfarlandi*. *P. mullicaensis* does not have quite so broad a columellar cavity relatively and

the shell is marked by stronger vertical folds. The columellar cavity of *P. macfarlandi,* however, is nearly as broad as that of *T. elevata.* The casts described by Whitfield as *Rostellaria curta* also resemble those called *Turbinopsis elevata* by the same author, and at least one of the type specimens of that species is certainly identical with *T. elevata.*

Although the casts under consideration are certainly not members of the genus *Turbinopsis,* they will be allowed to remain where they were originally placed by their author, because their reference to any other genus is just as unsatisfactory. Not until specimens preserving the external features of the shell are secured can their relations be properly determined.

The species is closely allied to *T. curta,* and three of the figures of *T. elevata,* published by Whitfield, are said by Johnson to represent the other species, leaving but a single specimen as the type of the species.

Formation and locality.—Navesink marl, near Crawfords Corner (126[7]), Crosswicks Creek (149), Mullica Hill (169).

Geographic distribution.—New Jersey.

Turbinopsis ? curta Whitfield.

Plate XCVIII., Figs. 4–5.

1892. *Turbinopsis curta* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 102, pl. 12, figs. 3–6.

1905. *Turbinopsis curta* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 26.

Description.—"Shell small, turbinate, with a short spire, showing in the cast only about three volutions in all, the last of which forms the great bulk of the shell; volutions largest at the top and contracted below to the sharp base bordering the umbilical cavity; this latter feature proportionally wide, indicating a large umbilicus in the shell; aperture elliptical, sharply angular below and sharply rounded above; oblique and more rounded on the outer than on the inner side; columellar lip not showing evidence of a tooth on the cast, and probably destitute of such appendage;

casts showing no indication of vertical folds or revolving lines." (Whitfield.)

Remarks.—This species may be recognized by its low spire, as compared with *T. elevata.* The two species are closely allied, and it is possible that this is really only an immature form of that species.

Formation and locality.—Navesink marl, Atlantic Highlands (108), Crosswicks Creek (149).

Geographic distribution.—New Jersey.

Turbinopsis ? major Whitfield.

Plate LXXXIII., Figs. 7-8.

1892. *Turbinopsis major* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18, p. 103, pl. 12, figs. 15-16. (Not figs. 21-23.)

Description.—The dimensions of the type specimen are: height, with the spire incomplete, 27.5 mm.; probable total height, 32 mm.; maximum diameter, 23 mm. Volutions large, heavy and massive, strongly rounded on the surface, and probably about five in number; spire short, the apical angle having been about 60°, making the height of the spire above the top of the body volution, when measured on the back of the shell, about equal to the length of the body volution from that point downward; aperture obliquely elliptical-ovate, as in other species of the genus; columellar cavity in the cast very large, the lower edge being raised above the general surface, indicating a notch or groove at the base of the aperture in the shell, with a rounded callosity above it, forming or representing the tooth or fold on the columellar.

Remarks.—Whitfield evidently had two different shells before him when he described this species. The larger specimen which he has illustrated resembles those large casts which he described under several different names, and which are all referred to *Anchura abrupta* in this report. The smaller specimen only is here considered as typical of the species. It is by no means cer-

tain that it is a member of the genus *Turbinopsis,* indeed it probably does not belong there. However, it cannot be placed in any genus satisfactorily and may be allowed to stand for the present where it was originally placed, awaiting the discovery of more perfectly preserved specimens.

Formation and locality.—Navesink marl, Navesink Hills (Whitfield).

Geographic distribution.—New Jersey.

Genus Morea Conrad.

Morea naticella Gabb.

Plate XCVIII., Figs. 14–15.

1860. *Purpura (Morea) naticella* Gabb, Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 4, p. 301, pl. 48, fig. 14.
1861. *Morea naticella* Gabb, Synop. Moll. Cret. Form., p. 115 (59).
1864. *Morea naticella* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 19.
1868. *Morea naticella* Con., Cook's Geol. N. J., p. 729.
1892. *Pyropsis Naticoides* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 43, pl. 2, figs. 5-7.
1892. *Morea naticella* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 97, pl. 12, figs. 19-20.
1905. *Pyropsis naticoides* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 24.
1905. *Morea naticella* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 26.

Description.—Shell of medium size, subglobular or subpyriform, with three or four ventricose volutions, which are most inflated on the upper third; the dimensions of a nearly complete internal cast are: height, 19 mm.; maximum diameter, 16 mm.; height of aperture, 17 mm.; width of aperture, 8 mm. Spire rather low; aperture broadly elliptical, pointed above and obtusely so at the base; columellar cavity of medium size, with a single strong spiral ridge near the anterior margin. Surface of the shell

marked by from 8 to 11 strong spiral ridges, leaving a plain space at the base of the shell equal in width to that of two of the ridges; surface marked also by somewhat more distant, transverse, broadly rounded ridges, which are nodose at the points of junction with the revolving ridges.

Remarks.—This species is apparently restricted to the fauna of the Merchantville clay. It may be easily recognized by its low spire, its surface markings, and by the strong columellar fold situated just within the umbilical margin. The type of the species is a large example, and has the markings more strongly impressed upon the surface of the cast than is usually the case. The specimen which Whitfield has described as *Pyropsis naticoides* must be referred to this same species, and this specimen perhaps represents more nearly the usual form of the species. The shell which has been described as *Turbinopsis plicata* is another closely allied shell, certainly congeneric, although it is probably a distinct species characterized by a somewhat higher spire and a broader umbilicus.

Formation and locality.—Merchantville clay, Lenola (163).

Geographic distribution.—New Jersey.

Morea plicata (Whitfield).

Plate XCVIII., Figs. 16–17.

1892. *Turbinopsis plicata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 104, pl. 12, figs. 1–2.

1905. *Turbinopsis plicata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 26.

Description.—"Shell small, and known only from internal casts; spire elevated and erect, composed of but few volutions, probably not more than three in the shell; widely separated in the casts by the sutures and very rapidly increasing in size; umbilical opening very large and very distinctly marked, near the base of the columella, by a deep, narrow groove, indicating the presence of a rather strong, tooth-like ridge at the base of the columella; columella concave, giving an elliptical form to the

filling of the aperture which nearly equals one-half the height of the entire cast, and is very oblique as seen in front, but from the back appears rather patulose and spreading; surface of the cast marked by numerous vertical folds or plications, which are quite distinct on the cast and closely arranged; the outer half of the last volution, however, does not retain them so distinctly." (Whitfield.)

Remarks.—This species resembles *M. naticella*, but it is more elongate, with a higher spire, more loosely coiled volutions and a much broader umbilicus, as indicated by the width of the umbilical cavity in the cast.

Formation and locality.—Navesink marl, Atlantic Highlands (108), Crosswicks Creek (Whitfield).

Geographic distribution.—New Jersey.

Family PLEUROTOMIDAE.

Genus PLEUROTOMA Lamark.

Pleurotoma farmingdalensis Whitfield.

Plate XCVIII., Figs. 18–19.

1892. *Pleurotoma farmingdalensis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 185, pl. 23, figs. 3–4.

Description.—"Shell of medium size, with an elongated, turreted spire, composed of numerous angularly ventricose volutions, which ascend rapidly, the entire number unknown; apical angle about 30°; body volutions proportionally larger than those above, contracted below and rapidly decreasing in diameter, terminating in a short anterior beak, the length of which is not known; periphery biangular on the outer two-thirds of the body whorl, as seen on the cast; columella slender, smooth; aperture moderately large; outer lip straightened along the middle; volutions marked on the angle by short, oblique, vertical plications or elongated nodes, which are directed slightly forward below, and are confined to the larger part of the volution on all above the last one, where they are slightly visible on the lower angle. About

12 of the vertical nodes may be counted on a single volution. The upper side of the last volution is slightly concave between the angle and the suture line, marking the probable position of the notch of the outer lip, although on the cast this feature itself cannot be positively traced." (Whitfield.)

Remarks.—This is a rare species and has not been met with in the recent collections of the Survey. All the known examples of the species are more or less fragmentary, and the characters are not preserved in as satisfactory a manner as might be desired.

Formation and locality.—Manasquan marl, Farmingdale (Whitfield).

Geographic distribution.—New Jersey.

Genus CITHARA Gray.

Cithara crosswickensis Whitfield.

Plate XCVIII., Figs. 20–21.

1892. *Cithara Crosswickensis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 107, pl. 13, figs. 7–8.
1905. *Cithara crosswickensis* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 26.

Description.—"Shell of moderate size or larger, subfusiform or turriculate, the spire as long as or longer than the length of the body volution and beak, only moderately slender, the apical angle being about 30° to 35°, and the number of volutions probably about five; all the specimens being imperfect and mostly casts, the exact number can not be determined; body volution large in proportion to the others, quite ventricose in the upper part and contracted below to form the short beak; upper volutions only moderately ventricose; suture, in the casts, strongly marked and the volutions rather abrupt on the upper margin; aperture large, angular above, and more sharply so below; columella strong, leaving a moderately large cavity by its removal, which, in the most perfectly formed cast, shows evidence of a single, rather strong, oblique plication on the lower part; volutions marked by

distant, strong and angular vertical folds, extending from the suture to near the base of the beak on the body volution, and from suture to suture on the others, even on the casts; surface of the shell marked by very fine transverse striæ parallel to the folds, which are only slightly directed forward in their lower part; and by extremely faint indications of faint thread-like, raised, spiral lines, divided by broad flattened interspaces." (Whitfield.)

Remarks.—This species is closely allied to *C. mullicaensis,* but according to Whitfild it is larger, with a more elevated and more slender spire, with the body volution proportionally larger, and the suture much more distinct. The species is apparently less common than *C. mullicaensis,* as it has not been met with in the recent collections. The internal casts of this species closely resemble those of *Odontofusus medians,* but they can be distinguished from that species by the absence of the columellar fold.

Formation and locality.—Navesink marl, Crosswicks Creek (Whitfield).

Geographic distribution.—New Jersey.

Cithara mullicaensis Whitfield.

Plate XCVIII., Figs. 22–28.

1892. *Cithara Mullicaensis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 106, pl. 13, figs. 2-6.

Description.—"Shell moderately large and robust for its length, with a short, obtusely pointed spire and very large body whorl, which constitutes nearly the entire bulk of the shell; the spire, measuring from the swell of the body volution when looking upon the front of the shell, forming about two-fifths of the entire height; volutions four and a half to five in number, short, indistinctly marked and the sutures obscure; the body whorl somewhat produced below, forming a short canal; aperture large, elliptical, pointed above and notched below; and about equaling one-half the length of the shell; surface of the shell marked with strong, longitudinal ribs, which are quite distant and number only about 10 on the body whorl; the ribs are strong, sharply

elevated, with concave interspaces, and with fine longitudinal lines of growth marking the surfaces; and the whole crossed by elevated thread-like raised lines, distant and distinct, but most plainly marked on the ridges; on the internal casts, the most usual condition, the spire is more elevated and the form less robust, with more distinct sutures and the volutions more ventricose, while their surfaces are less strongly marked by the longitudinal ribs, and no spiral lines are visible; no evidence of markings can be detected on the columella, either on the shell or on the cast. The outer lip of the aperture appears to have been slightly thickened, but no evidence of internal striæ exists. The features of the notch in the outer tip cannot be ascertained." (Whitfield.)

Remarks.—This is a well-marked and easily recognizable species, and at Mullica Hill it not infrequently occurs with the shell preserved. The internal casts are sometimes almost entirely smooth, without any indications of the vertical folds of the shell.

Formation and locality.—Navesink marl, Atlantic Highlands (108), Middletown (113[2]), near Red Bank (120), near Crawfords Corner (126[7]), Crosswicks Creek (147[4], 195), Mullica Hill (169).

Geographic distribution.—New Jersey.

Sub-class EUTHYNEURA.

Order OPISTHOBRANCHIA.

Sub-order TECTIBRANCHIATA.

Family ACTAEONIDAE.

Genus Actaeon Montfort.

Actaeon cretacea Gabb.

Plate XCIX., Figs. 1–6.

1845. *Tornatella* Forbes, Quart. Jour. Geol. Soc. Lond., vol. 1, p. 63, text fig. c.

1861. *Actæon cretacea* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 318.

1861. *Actæon ovoidea* Gabb, Proc. Acad. Nat. Sci. Phil. (1861), p. 319.
1864. *Actæon ovidea* Meek, Check List Inv. Foss. N. A., Cret. and Jour., p. 17.
1864. *Actæon cretacea* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 17.
1868. *Actæon cretacea* Con., Cook's Geol. N. J., p. 728.
1868. *Actæon ovoidea* Con., Cook's Geol. N. J., p. 728.
1892. *Actæon cretacea* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 158, pl. 19, figs. 9-12.
1892. *Actæon ovoidea* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 162, pl. 20, figs. 5-6.
1892. *Actæon Forbesiana* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 157, pl. 19, figs. 17-22.
1892. *Actæon subovoides* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 155, pl. 19, figs. 14-16.
1905. *Actæon cretacea* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 18.
1905. *Actæon forbesiana* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 19.
1905. *Actæon ovoidea* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 19.

Description.—Shell variable in size, subovoid in general form, with a moderately elevated spire; the dimensions of two individuals are: height, 39 mm. and 20 mm.; maximum diameter, 25 mm. and 11.5 mm.; height of spire, 10 mm. and 7 mm.; height of aperture, 29 mm. and 13 mm. Volutions four or five, with distinctly marked sutures in the cast; body volution large, forming the greater bulk of the shell, moderately convex in the middle and slightly pointed below; aperture large, about two-thirds of the total height of the shell, pointed at the upper end, and moderately increasing in width anteriorly, its greatest width considerably below the middle, obtusely pointed below. The columellar cavity in the casts rather wide and furnished with a single moderately strong tooth at about the broadest part of the aperture, which is often but weakly developed; surface of the shell

obscurely marked on the cast by a few rather broad spiral lines, which externally, as indicated by impressions, are narrow impressed lines.

Remarks.—The type specimens of *A. cretacea, A. ovoidea* and *A. forbesiana,* are all from the Navesink marl, and a careful consideration of all these specimens, as well as numerous others, has led to the conclusion that they all represent a single species, for which the prior name *A. cretacea* must be adopted. Whitfield's type of *A. subovoides* is also the type of Gabb's *A. ovoidea.* The several specimens which have been studied are somewhat variable as regards the proportional height of the spire, the diameter of the shell and in the strength of the columellar fold, but none of these variations appear to be constant enough or strongly marked enough to be considered as of specific value. The species sometimes attains a large size, as indicated by the dimensions of the large individual given above, but the more usual size of the species is that of the smaller individual whose dimensions are given. Besides occurring in the Navesink marl, the species has been recognized in the recent collections of the Survey, only in the Wenonah sand.

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]); Navesink marl, Atlantic Highlands (108), Crosswicks Creek (149).

Geographic distribution.—New Jersey.

Actaeon gabbana Whitfield.

Plate XCIX., Figs. 7–8.

1860, *Actæonina biplicata* Gabb, Proc. Acad. Nat. Sci. Phil. (1860), p. 93, pl. 2, fig. 13. (Not *Actaeon biplicata* D'Orbigny.)

1861. *Actaeonina biplicata* Gabb, Synop. Moll. Cret. Form., p. 94 (38).

1864. *Solidula biplicata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 17.

1868. *Solidula biplicata* Con., Cook's Geol. N. J., p. 728.

1876. *Actæon biplicata* Meek, Rep. Inv. Cret. and Tert. Foss. Up. Mo., pp. 281 and 282.

1892. *Actæon Gabbana* Whitf., Pal. N. J., vol 2 (Monog. U. S. G. S., vol. 18), p. 176, pl. 19, figs. 23–25.

1905. *Actæon gabbana* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 19.

Description.—"Shell of medium size, elongate ovate or subcylindrical in outline, spire moderately elevated, entire length and number of volutions unknown. Body volution cylindrical in the upper half, obtusely rounded below. Aperture narrow, pointed and very contracted above and rounded below, about four-fifths as long as the length of the body volution, measured on the same side. Columella slightly twisted below and marked by a single tooth near the base, as determined by the groove showing on the cast. Surface of the shell marked by fine spiral lines, the number undeterminable from the specimens examined." (Whitfield.)

The dimensions of an internal cast incomplete at the apex are: height, 25.5 mm.; if complete, it would doubtless be at least 30 mm.; maximum diameter, 11.5 mm.; height of aperture, 18.5 mm.

Remarks.—In the recent collections of the Survey this species has been observed only from the Woodbury clay, although the types of the species are apparently from the Navesink marl. The species differs from *A. cretacea* in its much more elongate and cylindrical form. It apparently resembles the shell described from Mississippi by Conrad as *Solidulus linteus*[1], but no examples of that species have been available for comparison, so that it cannot be determined whether the two are identical or not.

Formation and locality.—Woodbury clay, Lorillard (102), near Matawan (103); Navesink marl (Coll. Phil. Acad. Sci.).

Geographic distribution.—New Jersey.

Family RINGICULIDAE.

Genus AVELLANA d'Orbigny.

Avellana bullata (Morton).

Plate XCIX., Figs. 9–11.

1834. *Tornitella ? bullata* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 48, pl. 5, fig. 3.

[1] Jour. Acad. Nat. Sci. Phil., 2nd ser., vol. 3, p. 334, pl. 35, fig. 10.

1861. *Solidula bullata* Gabb, Synop. Moll. Cret. Form., p. 137 (81).

1864. *Solidula* (?) *bullata* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 17.

1868. *Solidula bullata* Con., Cook's Geol. N. J., p. 728.

1892. *Avellana bullata* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 163, pl. 20, figs. 1–4.

1905. *Avellana bullata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 19.

Description.—"Shell large for the genus, attaining fully an inch in length; very globose, the diameter being nearly as great as the height, at least equaling seven-eighths of the height. Spire low and rounded, and the base only slightly more pointed. Volutions between three and four in number, the outer half of the last one more abruptly deflected downward at the suture than the preceding ones, but again elevated near the aperture. Aperture narrow, pointed above and widest below and rounded; the length equal to about four-fifths of the entire length of the shell; columellar margin thickened and marked by horizontal ridges on the upper two-thirds of its length, and by two very strong, ridge-like teeth or plications below the middle, the upper of which is the stronger. Base and outer lip slightly thickened. Surface of the shell, as shown on the cast, marked by fine spiral lines, and by transverse lines of growth. Of the spiral lines about 30 may be counted on the outer half of the body whorl of the larger individual, those near the base being coarser than those above, but gradually becoming fainter in strength. On one of Dr. Morton's types the transverse lines are regular and but little less strongly marked than the spiral lines, so that the surface under a glass looks to be cut up into small nearly equal solid nodes." (Whitfield.)

Remarks.—In the recent collections of the Survey this species has only been observed from the Merchantville clay, although it seems to have been described from Navesink marl examples. The species differs from *Cinulia naticoides,* which has only been collected recently from the Navesink, in its larger

size, its stronger revolving markings and in the presence of two columellar folds.

Formation and locality.—Merchantville clay-marl, Lenola (163); Navesink marl?

Geographic distribution.—New Jersey.

Avellana costata (Johnson).

Plate XCIX., Fig. 21.

1898. *Cinulia costata* Johns., Ann. Rep. Geol. Surv. N. J., for 1897, p. 264.

1898. *Cinulia costata* Johns., Proc. Acad. Nat. Sci. Phil. (1898), p. 462, text fig. 1.

1905. *Cinulia costata* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 19.

Description.—"Shell with four whorls, spire prominent, body whorl with from 12 to 13 revolving grooves, which form an equal number of smooth, flat, revolving costæ; these average about double the width of the grooves. In one specimen the third and fourth costæ from the suture are about twice as wide as the others, and the two lower costæ are divided by a minute, impressed line. The first spiral whorl has six and the second five revolving grooves. Apical whorl smooth, suture deeply impressed. Aperture narrow, oblique, lip broad, thick and crenulated on the inner margin with eight small teeth-like projections, and extending to the suture, where it joins the callus of the peristome, which is continuous to the base of the columella; base with two oblique folds, above which is a prominent fold or plate extending at almost right angles to the columella; between this and the posterior angle of the aperture is a small, tooth-like projection.

Alt., 4; diam., 2½ mill." (Johnson.)

Formation and locality.—Woodbury clay ?, Deep well at Mount Laurel (Johnson).

Geographic distribution.—New Jersey.

Genus CINULIA Gray.

Cinulia naticoides (Gabb).

Plate XCIX., Figs. 12–13.

1860. *Actæonia naticoides* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 299, pl. 48, fig. 2.
1861. *Actaeonina naticoides* Gabb, Synop. Moll. Cret. Form., p. 94 (38).
1864. *Cinulia* (?) *naticoides* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 16.
1868. *Cinulia* (?) *naticoides* Con., Cook's Geol. N. J., p. 728.
1868. *Actæonina naticoides* Con., Cook's Geol. N. J., p. 728.
1892. *Cinulia* (*Oligoptycha*) *naticoides* Whitf., Pal. N. J., vol. 2, (Monog. U. S. G. S., vol. 18), p. 161, pl. 19, figs. 28–30.
1905. *Cinulia naticoides* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 19.

Description.—Shell small, subglobular in form, the dimensions of a nearly perfect internal cast being: height, 9 mm.; diameter, 8.8 mm. Volutions about three in number, spire very low, nearly conforming with the rotundity of the body volution. Aperture narrowly ovate, about two-thirds as high as the body volution, widest below, pointed above. Outer lip thickened and crenulate within. Columella short, the columellar lip marked by a single rather strong revolving fold, shown as a groove in the casts, situated low down. Surface of the shell marked by fine revolving lines very faintly shown on the casts. These lines are slightly raised and rounded on the casts, from 20 to 30 being present on the body volution.

Remarks.—This little species resembles *Avellana bullata,* but is much smaller and is marked by a single columellar fold. In the recent collections of the Survey it has been observed only from the Navesink marl, and *A. bullata* only from the Merchantville, although some specimens of the latter species in the collections of the Philadelphia Academy of Science are apparently from the Navesink.

Formation and locality.—Navesink marl, near Freehold (133), near Jacobstown (150).

Geographic distribution.—New Jersey.

Family BULLIDAE.

Genus BULLA Klein.

Bulla macrostoma Gabb.

Plate XCIX., Figs. 19–20.

1860. *Bulla macrostoma* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 301, pl. 48, fig. 15.

1861. *Bulla macrostoma* Gabb, Synop. Moll. Cret. Form., p. 97 (41).

1864. *Bulla macrostoma* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 16.

1905. *Bulla macrostoma* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 19.

Description.—Shell subglobular with two or three volutions, the length of a crushed individual being 34 mm., and its width, somewhat increased by crushing, 28.5 mm. Aperture very broad, broadly rounded in front and narrowly rounded posteriorly. Surface marked only by lines of growth.

Remarks.—A single crushed and distorted cast of this species has been met with in the recent collections of the Survey. This specimen has been compared, not only with the type of the species, but also with other examples from southern localities, and the identification is certainly correct.

Formation and locality.—Red Bank sand, near Middletown (112).

Geographic distribution.—New Jersey, Alabama, Mississippi.

Genus HAMINEA Leach.

Haminea mortoni (Forbes).

Plate XCIX., Figs. 14–16.

1845. *Bulla Mortoni* Forbes, Quart. Jour. Geol. Soc. Lond., vol. 1, p. 63, text fig. a.

1861. *Bulla Mortoni* Gabb, Synop. Moll. Cret. Form., p. 97 (41).
1864. *Bulla Mortoni* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 16.
1864. *Solidula Mortoni* Con., Cook's Geol. N. J., p. 728.
1864. *Bulla Mortoni* Con., Cook's Geol. N. J., p. 728.
1892. *Bulla Mortoni* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 165, pl. 20, figs. 7–9.
1892. *Bulla conica* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 189, pl. 23, figs. 12–13.
1905. *Bulla mortoni* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 19.

Description.—"Shell rather above a medium size in the larger individuals, two of the casts before me measuring almost 1¼ inches in length, with a transverse diameter of three-fourths of an inch. Form, elongate oval, almost equal in size above and below the middle, the upper end perceptibly the smallest, and the point of greatest diameter rather below the middle of the length. Upper end slightly truncate, and in the cast rather strongly perforate, indicating a solid axis or spire of considerable dimensions, the outer lip of the aperture rising somewhat above the truncation; aperture very elongate, narrow and rounded above, scarcely widening for the upper third of its length, then rather rapidly expanding below, but principally on the inner side, to twice the width at the lower third of that of the upper third of the length; base pointedly rounded and projecting considerably below the opposite part of the body whorl. Columella thickened and showing slight indications of an angularity on its inner edge, not visible except with a glass, looking within the cavity, then only on the larger well preserved specimens. Surface marked throughout with fine, nearly equidistant, spiral, depressed lines and obscure transverse undulations of irregularity of growth." (Whitfield.)

Remarks.—So far as known, this species occurs only in the Navesink marl, and being the only similar shell in the fauna of that formation, it can always be easily recognized. The example which Whitfield used as the type of his species *B. conica* is pre-

served in the collection of Columbia University, and judging from its lithologic characters, it, too, is from the Navesink, rather than from the Manasquan marl. Its characters are in no way essentially different from *B. mortoni,* and it may be safely considered as a synonym of that species. The species is here transferred from the genus *Bulla* to *Haminea,* because of the presence of the revolving lines.

Formation and locality.—Navesink marl, Atlantic Highlands (108), near Crawfords Corner (126[7]), Crosswicks Creek (Whitfield).

Geographic distribution.—New Jersey.

Family TORNATINIDAE.

Genus CYLICHNA Loven.

Cylichna recta Gabb.

Plate XCIX., Figs. 17–18.

1860. *Bulla recta* Gabb, Jour. Acad. Nat. Sci. Phil., 2d ser., vol. 4, p. 302, pl. 48, fig. 16.
1861. *Cylichna recta* Gabb, Synop. Moll. Cret. Form., p. 103 (47).
1864. *Cylichna recta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 16.
1868. *Cylichna recta* Con., Cook's Geol. N. J., p. 728.
1892. *Cylichna recta* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 164, pl. 20, figs. 10–11.
1905. *Cylichna recta* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 19.

Description.—"Shell small, measuring only about half an inch in extreme length, form cylindrical, largest below, with nearly straight sides; spire deeply sunken in the cast; aperture large and the lip nearly straight on the sides, but gradually expanding below; columella curved; surface unknown." (Whitfield).

Formation and locality.—Wenonah sand, near Crawfords Corner (126[3]); Navesink marl, near Freehold (133); also Burlington County (Gabb.)

Geographic distribution.—New Jersey.

Class CEPHALOPODA.

Sub-class TETRABRANCHIATA.

Order NAUTILOIDEA.

Family CLYDONAUTILIDAE.

Genus HERCOGLOSSA Conrad.

Herecoglossa paucifex (Cope).

Plate CII., Fig. 1.

1866. *Aturia paucifex* Cope, Proc. Acad. Nat. Sci. Phil., 1866, p. 3.
1868. *Hercoglossa paucifex* Con., Cook's Geol. N. J., p. 731.
1892. *Hercoglossa paucifex* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 246, pl. 39, fig. 1.
1905. *Hercoglossa paucifex* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 28.

Description.—"Shell large, somewhat ponderous, ventricose, with a broadly rounded back and convex sides; umbilicus slightly impressed, but not open, the inner edge of the lip rather overlapping the one within, and the outer volution embracing the inner to that extent; aperture large, forming half of a long ellipse, being rounded on the outer margin and gradually expanding to the edge of the umbilical depression, or for nearly four-fifths of the entire length of the opening. On the inner side it is strongly modified by the projection of the inner volution; entire length of the apertural opening, 5½ inches on the specimen; greatest width across, nearly 4 inches. Septa strong, deeply concave and distant, being nearly 3 inches apart on the back of the specimen described at the third chamber, and nine chambers only visible to the volution; lateral septal processes situated nearer to the outer margin than to the umbilicus, and are large, strong, slightly directed outward from a circular line half as wide across the origin as long, that of the second septum shown on the specimen being 2 inches long from the curve of the inner por-

tion of the septum and 1¼ inches on the outer side. Inner portion of the septal line moderately arched forward between the umbilical line and the septal process (or lateral lobe) and reaching slightly in advance of the outer division, which from the base of the process or lobe extends almost directly across the back of the shell; siphon rather large, measuring more than a quarter of an inch in diameter at the outer chamber, cylindrical as far as can be seen; situated at about one-fifth or a little more than one-fifth of the distance from the margin of the inclosed volution to the back of the shell from the inner edge. Prof. Cope states at the edge of the inner fourth.

The shell substance, some of which remains on the inside of the cast and between two of the chambers, has been very thick, more than a sixteenth of an inch, and presents an imperfect columnar or prismatic structure on the edge. The sides of the cast also show it to have been very heavy where the septa have joined the outer shell, as the cast shows the ridges and chamfering of the edges when the shell has been removed. Some of the cavities left between the filling of chambers also are nearly or quite a line in thickness. Longitudinal lines also mark the cast, showing evidence of muscular attachment along the sides of the chambers between the umbilical cavity and the septal processes or lateral lobes of the septa." (Whitfield.)

Remarks.—This species has not been met with in the recent collections of the Survey. It is possible that it may be identical with *Nautilus orbiculatus* Tuomey, from Alabama, which was used by Conrad as the type of his genus *Hercoglossa*[1], but the original description of the southern species is so meagre that it is not possible to determine its characters certainly, in the absence of the type, whose whereabouts is unknown.

Formation and locality.—Hornerstown marl, Glassboro (Cope), Vincentown (Whitfield).

Geographic distribution.—New Jersey.

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[1] Proc. Acad. Nat. Sci. Phil., vol. 7, (1845), p. 167.

Family NAUTILIDAE.

Genus NAUTILUS Linneus.

Nautilus dekayi Morton.

Plate C., Figs. 1–5.

1833. *Nautilus Dekayi* Mort., Am. Jour. Sci., 1st ser., vol. 23, p. 291, pl. 8, fig. 4.
1834. *Nautilus Dekayi* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 33, pl. 8, fig. 4, pl. 13, fig. 4.
1856. *Nautilus Dekayi* Meek & Hayden, Proc. Acad. Nat. Sci. Phil., vol. 8, p. 280.
1859. *Nautilus Dekayi* Meek, Northwest Terr., Rep. Prog. Assin. and Saskat. Expl. Exped., H. Y. Hind, p. 185, pl. 2, figs. 9–10.
1861. *Nautilus Dekayi* Gabb, Synop. Moll. Cret. Form., p. 86 (30).
1864. *Nautilus Dekayi* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 25.
1868. *Nautilus Dekayi* Con., Cook's Geol. N. J., p. 731.
1876. *Nautilus Dekayi* Gabb, Proc. Acad. Nat. Sci. Phil., 1876, p. 277.
1876. *Nautilus Dekayi* Meek, Rep. Inv. Cret. and Ter. Foss., Up. Mo., p. 496, pl. 27, figs. 1a-e.
1892. *Nautilus Dekayi* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 243, pl. 37, figs. 1–6, pl. 38, figs. 1–4.
1894. *Eutrephoceras Dekayi* Hyatt, Proc. Am. Phil. Soc., vol. 32, p. 555, pl. 13, figs. 4–8, pl. 14, fig. 1.
1905. *Eutrephoceras dekayi* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 28.

Description.—"Shell of medium size, strongly subglobose in general form. In the condition of casts, that in which it is usually found in New Jersey, it is slightly umbilicate, but in the shell the axis is solid and somewhat extended laterally from the body of the volution, so that the posterior margin of the aperture

is straightened on each side of the involved inner whorl, and as seen from the back of the shell presents a strongly auriculate feature, like that of a globular *Bellerophon*. Section of the volution from the umbilicus outward more than semicircular, and the umbilical region impressed in the shell, or somewhat funnel-formed in the cast; aperture large, transverse, nearly twice as wide as long measured from the involved volution, which strongly modifies the form of the aperture and gives it a strongly reniform character; septa distant and very deeply concave, the sutures very nearly at right angles to the axis on the main portion of the volution, but forming a very slight backward sinus on the middle of the back, and also slightly bent backward within the umbilical depression as seen on the casts; siphon subcentral, a little nearer to the ventral than to the dorsal margin. Surface of the shell marked by fine transverse lines of growth which are arched strongly backward in crossing the middle of the shell, and forward on the sides." (Whitfield.)

Formation and locality.—Navesink marl, Atlantic Highlands (108), Mullica Hill (169); Red Bank sand, Shrewsbury River (119).

Geographic distribution.—New Jersey, Delaware, Alabama, Mississippi, Tennessee, Arkansas, Texas, Nebraska, Montana, Canada.

Nautilus bryani Gabb.

Plate CI., Figs. 1–2.

1876. *Nautilus Bryani* Gabb, Proc. Acad. Nat. Sci. Phil., 1876, p. 277.
1892. *Nautilus Bryani* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 244, pl. 38, figs. 5–6.
1905. *Nautilus bryani* Johns., Proc. Acad. Nat. Sci. Phil. 1905, p. 28.

Description.—"Shell large and strong, somewhat compressed on the sides; giving a section to the volution, from the margin of the umbilicus to the dorsum, greater than the width from side

to side. Umbilicus small, but open in the shell. Venter sharply rounded. Septa distant, rather deeply concave; arched forward on the margin of the umbilicus and slightly backward on the sides, but strongly arched forward on the venter. Siphon rather large, situated about two-fifths of the entire distance of the length of the septum from the inner border. Aperture as shown by the section of the volution, longer than wide and deeply emarginate on the inner border by the intrusion of the inner volution, giving it a compressed reniform outline. Surface of the shell unknown." (Whitfield.)

Remarks.—This species is known only from the type specimens, which are two incomplete individuals. The species differs from *N. dekayi,* which occurs at a lower horizon, in the conspicuous lateral compression of the shell, and the larger umbilicus.

Formation and locality.—Vincentown limesand, Vincentown (Gabb).

Geographic distribution.—New Jersey.

Order AMMONOIDEA.

Sub-Order LEPTOCAMPYLI.

Family SILESITIDAE.

Genus PACHYDISCUS Zittel.

Pachydiscus complexus (Hall and Meek)?

Plate CI., Figs. 3–4.

1854. *Ammonites complexus* H. & M., Mem. Am. Acad. Arts and Sci., n. ser., vol. 5, p. 394, pl. 4, figs. 1 a-f.

1861. *Ammonites complexis* Gabb, Synop. Moll. Cret. Form., p. 65 (9).

1864. *Ammonites complexus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 24.

1868. *Ammonites complexus* Con., Cook's Geol. N. J., p. 730.

1876. *Ammonites complexus* Meek, Rep. Inv. Cret. and Ter. Foss. Up. Mo., p. 447, pl. 24, figs. 1 a-c.

1892. *Ammonites complexus* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 249, pl. 41, figs. 5–7.

Compare:

1852. *Ammonites flaccidicosta* Roem., Kreide. von Texas, p. 33, pl. 1, figs. 1 a-b.

1861. *Ammonites flaccidicosta* Gabb, Synop. Moll. Cret. Form., p. 66 (10).

1864. *Ammonites flacidicosta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 24.

Description.—This species is represented in the New Jersey collections only by fragmentary specimens, too incomplete to admit of a complete description. The shell is apparently somewhat compressed subglobular, with a broadly rounded venter, and an umbilicus of moderate size, the inner volutions being covered by the outer ones for from one-third to one-half their width; surface marked near the umbilicus by a row of small, transversely elongate nodes which, on the outer volution of the larger specimens, extend outward and bifurcate, to form a series of rather distant, more or less obscure costæ, which, with others intercalated between, pass over the periphery; the septa are very complex and closely crowded.

The diameter of the largest example observed from New Jersey must have been nearly 60 mm. when the shell was complete, but it is too imperfect to admit of accurate measurement.

Remarks.—Whitfield has illustrated a fragment of an ammonite which he has referred to this species, and in the recent collections of the Survey fragments of another individual have been collected from the Wenonah sand near Marlboro. The locality and horizon of Whitfield's specimen cannot be determined. The Wenonah sand specimen resembles somewhat closely, in so far as it is preserved, a specimen in the National Museum at Washington, from the Ripley horizon at Chatfield, Texas, which is labeled *Ammonites flaccidicosta* Roem., and it is possible that the New Jersey specimens should be referred to that species rather than to *complexus*. Both of these species are apparently members of the genus *Pachydicus*. More perfect material is necessary

for study before the New Jersey specimens can be identified with certainty.

Formation and locality.—Wenonah sand, near Marlboro (130); Unknown (Whitfield.)

Geographic distribution.—New Jersey, Texas, Dakota, Nebraska.

Genus BACULITES Lamark.

Baculites ovatus Say.

Plate CIX., Fig. 5.

1820. *Baculites ovata* Say, Am. Jour. Sci., 1st ser., vol. 2, p. 41.
1828. *Baculites ovata* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 89, pl. 5, figs. 5–6.
1830. *Baculites ovatus* Mort., Am. Jour. Sci., 1st ser., vol. 17, p. 280; vol. 18, p. 249, pl. 1, figs. 6–8.
1830. *Baculites ovatus* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 196, pl. 5, figs. 5–6; pl. 8, figs. 6–8.
1834. *Baculites ovatus* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 42, pl. 1, figs. 6–8.
1853. *Baculites ovatus* Marcou, Explan. Text to Geol. Map U. S. and Brit. Prov. N. A., p. 46, pl. 7, fig.5.
1856. *Baculites ovatus* Hall & Meek, Mem. Am. Acad. Arts and Sci., new ser., vol. 5, p. 399, pl. 5, figs. 1 a-c, pl. 6, figs. 1–7.
1861. *Baculites ovatus* Gabb, Synop. Moll. Cret. Form., p. 78 (22).
1864. *Baculites ovatus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 23.
1868. *Baculites ovatus* Con., Cook's Geol. N. J., p. 730.
1875. *Baculites ovatus* White, U. S. Geog. and Geol. Expl. and Surv. w. 100th Merid., p. 199, pl. 19, figs. 4a-c, 5a-c.
1876. *Baculites ovatus* Meek, Rep. Inv. Cret. and Ter. Foss., Up. Mo., p. 394, pl. 20, figs. 1a-b, 2a, b, d.
1889. *Baculites ovatus* Whiteaves, Cont. Can. Pal., vol. 1, p. 181.

1892. *Baculites ovatus* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 275, pl. 46, figs. 3–9.

1896. *Baculites ovata* Say, Bull. Am. Pal., vol. 1, No. 5, p. 19 (289).

1905. *Baculites ovatus* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 181.

Description.—Shell attaining a rather large size, elongate, gradually tapering, cross-section ovate, the ventral or siphonal side somewhat more narrowly rounded than the opposite. The dimensions of the cross-section of a large individual are 45 mm. by 26 mm. Surface of shell usually smooth, the sides of the living chamber sometimes with ill-defined, broadly curved, obliquely transverse ribs or undulations whose greatest forward extension is on the ventral side; the apertural margin doubtless conformed with these undulations, having a long tapering extension on the ventral side, narrowly rounded at the extremity, the dorsal margin being more broadly rounded and the lateral margins with rather broad and deep sinuses just in front of the dorsal lip. The septa show considerable variation in different individuals as to their distance apart, some being crowded while others are more or less remote; the ventral or siphonal lobe is broad, with two terminal, widely separated, somewhat spreading branches, each of which is secondarily lobed upon the sides and extremity; first lateral saddle about as wide as high, but narrower than the ventral lobe, bifid at the extremity, each division being secondarily lobed; first lateral lobe deeper than wide, rather deeply bifid, each division with several secondary divisions; second lateral saddle similar to the first; second lateral lobe broader and shorter than the first, but somewhat similarly divided; third lateral saddles occupying the dorsal side, smaller than the others, bifid at the extremity with the inner division higher than the outer, and both of them secondarily lobed; dorsal lobe very small, smaller than or no larger than the terminal divisions of the adjacent lateral saddles.

Remarks.—There has always been more or less difference of opinion as to the relationship of this species with *B. compressus*

Say. The two forms differ chiefly in the outline of the cross-section, *B. compressus* being much more compressed towards the ventral side. The type of *B. ovatus* was from Monmouth County, N. J., while that of *B. compressus* was from the upper Missouri country. The New Jersey specimens, so far as they have been observed, all agree in essential details with the type of *B. ovatus,* but in the west both forms seem to occur along with intermediate forms which seem to connect the two types. In his studies upon the Cretaceous faunas of the north-west, Meek[1] has recognized the two forms as distinct species, identifying both of them from the upper Missouri country, and he has usually been followed by authors. Whitfield,[2] however, would consider the two forms as geographic variations only, of one general species, and would refer all the Western examples to *B. compressus* and the eastern ones to *B. ovatus.* Whatever may be the status of the two species, or whatever may be the relationship of the eastern and western forms, there can be no doubt as to the proper reference of the New Jersey specimens to *B. ovatus,* as this was the first of the two forms described, and if either name is ever abandoned it will be *B. compressus;* however, it will probably always be a matter of convenience to retain the two names for the two forms of shells, even though it may be shown that in some localities their characters intergrade.

Formation and locality.—Merchantville clay-marl, Lenola (163); Woodbury clay, Lorillard (102); Navesink marl, Atlantic Highlands (108), near Holmdel (194), near Walnford (148[2]), Crosswick Creek (147[4], 195), Mullica Hill (169[2]).

Geographic distribution.—New Jersey, Alabama, Dakota, Montana, Colorado.

Baculites asper Morton ?.

Plate CIX., Figs. 6–7.

1834. *Baculites asper* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 43, pl. 1, figs. 12–13; pl. 13, fig. 2.

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[1] Rep. Inv. Cret. and Ter. Foss. Up. Mo. pp. 394–397.

[2] Pal. N. J. vol. 2, pp. 277–278.

1861. *Baculites asper* Gabb, Proc. Acad. Nat. Sci. Phil., 1861, p. 396, pl. 3, fig. 4.
1864. *Baculites asper* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 23.
1876. *Baculites asper* ? Meek, Rep. Inv. Cret. and Ter. Foss. Up. Mo., p. 404, pl. 39, figs. 10 a-d.
1892. *Baculites asper* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 278, pl. 46, figs. 10–11.
1905. *Baculites asper* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 26.

Remarks.—Whitfield has identified a fragment of a large individual having a maximum diameter of 55 mm. with this species. In the recent collections of the Survey a fragment of the living chamber of a small individual with a maximum diameter of but 10 mm. may possibly represent the species. Neither of these specimens can be identified with certainty, and the two may not belong to the same species, but both are characterized by somewhat conspicuous node-like inflations of the sides of the shell, and they may be referred to this species for the present with a query.

Formation and locality.—Cliffwood clay, Cliffwood Point (105); Navesink marl, Holmdel (Whitfield).

Geographic distribution.—New Jersey.

Family SCAPHITIDAE.

Genus SCAPHITES Parkinson.

Scaphites nodosus Owen ?.

Plate CVII., Figs. 1–2.

1852. *Scaphites (Ammonites ?) nodosus* Owen, Geol. Surv. Ia., Wis. and Minn., p. 581, pl. 8, fig. 4.
1861. *Scaphites nodosus* Gabb, Synop. Moll. Cret. Form., p. 89 (33).
1864. *Scaphites nodosus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 24.

1876. *Scaphites nodosus* Meek, Rep. Inv., Cret. and Ter. Foss. Up. Mo., p. 426, 428, 429, pl. 25, figs. 1a-c, pl. 25, figs. 3 a-c, 2 a-c, 4, pl. 26, figs. 1 a-c.

1880. *Scaphites nodosus* Whitf., Geol. Black Hills, p. 441, pl. 13, fig. 12.

1892. *Scaphites nodosus* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 261, pl. 44, figs. 13-14.

1898. *Scaphites nodosus* var *brevis* Logan, Univ. Geol. Surv. Kas., vol. 4, p. 511, pl. 108, fig. 3.

1899. *Scaphites nodosus* Logan, Field Col. Mus., Pub. 36, Geol. Ser., vol. 1, p. 209, pl. 22, fig. 2.

1905. *Scaphites nodosus* var. *brevis* Smith, Jour. Geol., vol. 13, p. 640.

Description.—Shell subovate in general outline, the last volution becoming somewhat free from the inner ones in its outer half, the living chamber ventricose. Sides of the shell somewhat flattened, curving inward to the umbilicus, the venter broad, more or less convex, the cross-section often somewhat quadrangular; on either side of the shell, at the margins of the convex venter, there is a conspicuous row of rounded or somewhat compressed nodes; toward the umbilical margin there is a second row of tubercles on each side which are smaller than those of the outer row; across the venter, between the two outer rows of tubercles the surface of the shell is marked by a series of regular transverse ribs whose distance apart is usually one-third or one-fourth the distance between the tubercles; upon the sides of the adult shell the ventral ribs do not continue, but the surface is marked by much coarser, more or less indistinct ribs joining the outer and inner rows of tubercles; these ribs also continue somewhat down the umbilical slope.

Remarks.—The New Jersey specimens which have been identified as *S. nodosus* are all extremely fragmentary, and if they were more perfectly preserved it is possible that they might be found to represent a distinct species. The best example seen, so far as it is preserved, agrees very well in general form with Owen's type specimen of *S. nodosus,* which is preserved in the

collection of the Walker Museum at the University of Chicago, except that the transverse ribs which cross the ventral side only of the New Jersey specimen, continue in the type without interruption to the umbilical margin. This same difference between the New Jersey and the western specimens is noticeable in all the examples from both regions which have come under observation in which the markings of the sides of the shell can be seen.

Formation and locality.—Merchantville clay-marl ?, New Jersey (Whitfield); Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey, Dakota,, Montana, Kansas.

Scaphites hippocrepis (De Kay).

Plate CVII., Figs. 3–6.

1827. *Ammonites hippocrepis* De Kay, Ann. N. Y. Lyc. Nat. Hist., vol. 2, pp. 273-277, pl. 5, fig. 2 (5).
1828. *Scaphites Cuvieri* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 109, pl. 7, fig. 1.
1834. *Scaphites hippocrepis* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 41, pl. 7, fig. 1. (*S. Cuvieri* on plate.)
1861. *Scaphites hippocrepis* Gabb, Synop. Moll. Cret. Form., p. 88 (32).
1864. *Scaphites hippocrepis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 24.
1868. *Scaphites hippocrepis* Con., Cook's Geol. N. J., p. 730.
1892. *Scaphites hippocrepis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 262, pl. 44, figs. 8-12.
1892. *Scaphites similis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 267, pl. 44, figs. 1-2.
1905. *Scaphites hippocrepis* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 27.
1905. *Scaphites similis* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 27.

Description.—Shell subovate in general outline; the living chamber ventricose, rounded on its ventral side, with a decided

geniculate curvature, its greatest transverse diameter below the outer angle of the horizontal portion a little within the point from which rises the margin of the hood-like aperture; beyond this point the diameter decreases more or less rapidly to the aperture; number of inner coils not determined, broadly rounded on the ventral side, their dorso-ventral diameter less than the transverse when not distorted, closely coiled, the umbilicus very small; from the last septum the dorsal margins of the living chamber rise abruptly in a straight line from the umbilicus to a point beyond the venter of the second volution and then again curve forward at nearly a right angle; the ventral margin has nearly the same direction as the dorsal, but the lower portion of the living chamber is not so nearly vertical and the curve to the forward direction is longer. Surface of the shell, to the beginning of the living chamber, marked with rather sharp transverse ribs which continue around the shell from umbilicus to umbilicus, increasing by division and intercalation at about the middle of the sides of the shell where there is a more or less indistinct row of small nodes; upon the lower vertical portion of the living chamber the transverse ribs become more remote and are nearly obsolete upon the sides of the shell beyond the row of nodes which become gradually more conspicuous towards the aperture; at the geniculate curve of the venter of the living chamber the transverse ribs again become more approximate, and so continue to the aperture; they do not, however, continue across the sides of the shell beyond the row of nodes; near the dorso-lateral margins of the living chamber just opposite the geniculate curve, there are two rather strong nodes on each side of the shell, the ones farthest from the aperture being the largest nodes upon the shell and through which is the greatest transverse diameter of the shell. Sutures comparatively simple, with a ventral and three lateral lobes; the ventral lobe with a broad, rounded siphonal saddle and two secondary lobes on each side, the lateral lobes becoming successively smaller and less complicated to the umbilical margin; the first lateral saddle broad with three major divisions, each of which is bifid; the second lateral saddle deeply bifid, the third simple or very slightly bifid; the larger indenta-

tions of both lobes and saddles are more or less deeply bifid or trifid.

Remarks.—This species is the common Scaphite of the Merchantville clay. It is different from all other American representatives of the genus in the peculiar expansion of the living chamber to the geniculate bend beyond which it rapidly contracts to the aperture. Whitfield's *S. similis* is evidently only a young individual of *S. hippocrepis.*

Formation and locality.—Merchantville clay, near Matawan (101), near Jamesburg (139), Lenola (163).

Sub-order PACHYCAMPYLI.

Family SPHENODISCIDAE.

Genus SPHENODISCUS Meek.

Sphenodiscus lobatus (Tuomey).

Plate CVI., Figs. 1–2.

1854. *Ammonites lobata* Tuomey, Proc. Acad. Nat. Sci. Phil., vol. 7, p. 168.
1861. *Ammonites lobata* Gabb, Synop. Moll. Cret. Form., p. 69 (13).
1864. *Ammonites lobatus* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 24.
1868. *Ammonites lobatus* Con., Cook's Geol. N. J., p. 730.
1892. *Ammonites* (*Sphenodiscus*) *lenticularis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 258, pl. 41, figs. 8-9.
1903. *Sphenodiscus lobatus* Hyatt, Monog. U. S. G. S., vol. 44, p. 66, pl. 6, figs. 1-2, pl. 7, figs. 1-2 pl. 9, figs. 11-13.

Description.—Shell attaining a large size, large examples having a diameter of 220 mm. or more; compressed-lenticular in form, the outer volutions almost completely embracing the inner, leaving but a small or nearly closed umbilicus; the sides of the volutions smooth, gently convex from the umbilical to the ven-

tral margins, the venter acutely angular; aperture narrowly saggitate in outline. Sutures complex, somewhat crowded; the ventral lobe broad with a minute siphonal saddle, on either side of which is a minute, bifid lobe; at the lateral extremities of the ventral lobe is a pair of trifid, palmately spreading divisions; lateral lobes 11 or 12 in number, the first three much the largest, deeply divided in palmately spreading branches; beyond the third lateral lobe the lobes rapidly decrease in size, retaining the same style of division but becoming less complicated; lateral saddles rounded or with rounded divisions, the first six or seven bifid, each of the main divisions of the larger ones also bifid except the first, in which the outer division remains simple while the inner one is bifid.

Remarks.—This species has been identified from mere fragments by Whitfield as *S. lenticularis* Owen, and in some respects it approaches very close to that species, especially to the variety *splendens* of Hyatt.[1] The suture of a large New Jersey example is fully as complex as, and in many respects more closely resembles that of the type of this variety, than it does any of the illustrations of *S. lobatus.* The smaller saddles, however, of the New Jersey specimens are much more depressed than those shown in the illustrations of *S. lenticularis* var. *splendens,* agreeing in this respect with the figures of *S. lobatus.* In New Jersey the species seems to be characteristic of the Tinton beds as it has not been observed elsewhere, and at least fragments of it have been found wherever fossils have been at all extensively collected from those beds.

Formation and locality.—Tinton beds, Tinton Falls (110), Beers Hill cut (129), near Freehold (132).

Geographic distribution.—New Jersey, Alabama, Mississippi.

[1] Monog. U. S. G. S., vol. 44, p. 75, pl. 8, figs. 3–7.

Family PLACENTICERATIDAE.

Genus PLACENTICERAS Meek.

Placenticeras placenta (DeKay).

Plate CIV., Fig. 6; Plate CV., Fig. 1.

1828. *Ammonites placenta* DeKay, Ann. N. Y. Lyc. Nat. Hist., vol. 2, p. 278, pl. 5, fig. 2.
1830. *Ammonites placenta* Mort., Am. Jour. Sci., 1st ser., vol. 17, p. 279; vol. 18, pl. 2, figs. 1-3.
1830. *Ammonites placenta* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 195, pl. 5, fig. 4.
1834. *Ammonites placenta* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 36, pl. 2, figs. 1-2.
1861. *Ammonites placenta* Gabb, Synop. Moll. Cret. Form., p. 71 (15), (in part).
1864. *Ammonites placenta* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 25 (in part).
1868. *Ammonites placenta* Con., Cook's Geol. N. J., p. 730.
1892. *Ammonites (Placenticeras) placenta* Whitf., Pal. N. J., vol. 2, Monog. U. S. G. S., vol. 18), p. 255, pl. 4, fig. 1, pl. 41, figs. 1-2.
1903. *Placenticeras placenta* Hyatt, Monog. U. S. G. S., vol. 44, p. 211, pl. 39, figs. 3-6, pl. 40, figs. 1-2.
1905. *Placenticeras placenta* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 27.

Description.—Shell attaining a large size, full-grown individuals reaching a diameter of 400 mm. or more; subdiscoidal or lenticular in form with a deep and distinct though rather small umbilicus, the sides of which are gently rounded to the lateral surface of the volutions, only a small portion of each of the inner volutions exposed; venter narrow and distinctly flattened in the casts of young individuals and bordered on each side by a row of distinct nodes which alternate in position on the two sides, in the larger and more mature individuals the venter becomes

rounder and the nodes disappear; sides of the shell gently convex from the umbilical shoulder to the venter, in young individuals with a row of distinct and somewhat sharp umbilical nodes, and a second row of somewhat less prominent nodes about one-third of the distance from the ventral to the umbilical margins; in the larger individuals these nodes disappear; aperture elongate-saggitate in outline. Septa closely interlocking, the lobes and saddles of comparatively small size but very complicated, and varying with the growth of the shell; the ventral lobe is rather broad, passing straight across the venter except for numerous minute crenulations, with a conspicuous lateral extension on each side; the first three lateral lobes are much larger than the others and have from three to five main divisions besides numerous finer serrations; at the base of the third lateral lobe the general direction of the suture bends abruptly forward to the top of the fourth lateral saddle, where it bends toward the umbilicus again and continues to the dorsal margin; beyond the large third lateral lobe there are about six additional, more or less bifid or trifid lobes which regularly decrease in size towards the umbilicus; the saddles are fully as complicated as the lobes, but their general outlines are broader and rounder.

The dimensions of a large individual are: diameter of shell, 222 mm.; height of outer volution from venter to umbilical margin, 114 mm.; greatest thickness of outer volution, 50 mm.

Remarks.—This species, originally described from the Delaware and Chesapeak Canal, occurs commonly in New Jersey in the formations beneath the Navesink marl. A similar species from the Upper Cretaceous of the West has usually been identified with the New Jersey form, but Hyatt has recently separated the western one under the name *P. whitfieldi*, restricting the name *P. placenta* to certain forms from New Jersey and Alabama.[1] In New Jersey the species reaches its greatest development both numerically and as to size, in the Merchantville clay-marl, in which formation as exposed at Reeves' clay pits at Lenola, the most and best and largest examples have been collected. The species also occurs in the Cliffwood clays beneath

[1] Monog. U. S. G. S., vol. 44, p. 221.

the Merchantville and in the Woodbury, Marshalltown and Wenonah formations above, but all the examples from these other horizons which have come under observation, are more fragmentary and smaller.

Formation and locality.—Cliffwood clay, Cliffwood Point (105); Merchantville clay-marl, near Matawan (100[4], 101), near Jamesburg (141), Lenola (163); Woodbury clay, Lorillard (102), near Matawan (103); Marshalltown clay-marl, near Swedesboro (177); Wenonah sand, near Crawfords Corner (126[3]), near Marlboro (130[1]).

Geographic distribution.—New Jersey, Alabama.

Placenticeras telifer (Morton).

Plate CIV., Figs. 7–8.

1834. *Ammonites telifer* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 38, pl. 2, fig. 7.

1861. *Ammonites telifer* Gabb, Synop. Moll. Cret. Form., p. 73 (17).

1892. *Ammonites* (*Placenticeras*) *telifer* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 257, pl. 41, figs. 10–11.

1903. *Placenticeras* ? *telifer* Hyatt, Monog. U. S. G. S., vol. 44, p. 233.

1905. *Placenticeras telifer* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 28.

Remarks.—This species was established by Morton upon three fragments, one of which gives the characters of one lobe of the septa with small portions of others. In regard to the species Hyatt says, "After examining the fragments of this species in the collection of the Academy of Sciences, Philadelphia, I am unable to determine with certainty whether this is a species of this genus or not, and the details of the sutures, so far as my hasty examination went, were too imperfect to enable me to make a reasonable guess with regard to their affinities."

Formation and locality.—Cretaceous, New Jersey (Morton).

Geographic distribution.—New Jersey.

Family HAMITIDAE.

Genus HETEROCERAS d'Orbigny.

Heteroceras conradi (Morton).

Plate CVIII., Figs. 5-8.

1841. *Ammonceratites Conradi* Mort., Proc. Acad. Nat. Sci. Phil., vol. 1, p. 109.
1841. *Ammonceratites Conradi* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 8, p. 212, pl. 10, fig. 1.
1861. *Helicoceras Conradi* Gabb, Synop. Moll. Cret. Form., p. 84 (28).
1864. *Helicoceras Conradi* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 25.
1868. *Cirroceras Conradi* Con., Cook's Geol. N. J., p. 730.
1892. *Heteroceras Conradi* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 269, pl. 45, figs. 9-14.
1905. *Heteroceras conradi* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 27.

Description.—Species known only from fragmentary examples, most of which are portions of the living chamber; they indicate that different individuals differed in their curvature, some being dextral and others sinistral. Most of the specimens are somewhat U-shaped, the distal portion of the shell apparently bending downward to a nearly vertical position from the last spiral coil and then curving up again to form the U, this portion of the shell being similar to *H. simplicostatus* Whitf.,[1] except that the two sides of the U are more closely compressed together. The tube is more or less subcircular in cross-section or is compressed in one direction. Surface of the shell marked by strongly angular transverse ribs, and upon the living chamber, at least, by a double row of more or less strongly developed nodes which are either somewhat lateral in position or are situated upon the

[1] See Bull. Am. Mus. Nat. Hist., vol. 16, pp. 67–72, plates 23–27, especially plate 27.

outer side of the U-shaped tube; often in the space between the rows of nodes the ribs are more or less obsolescent. Sutures essentially unknown.

Remarks.—The fragmentary condition of all the examples of this species which have been observed makes it very difficult to determine just what its form has been; if all the parts which have been observed really belong to a single species it must have been very variable in the curvature of the shell and in the ornamentation. The type of the species is a nearly complete spiral coil, but most of the later specimens which have been collected are U-shaped. The species was doubtless one which passed through several distinctly different forms of growth and curvature, being similar in this respect to the *H. simplicostata* Whitf., already mentioned. The species is perhaps really more closely allied to *H. angulatum* M. & H.,[1] than to any other, but this species also is known only from fragments

Formation and locality.—Navesink marl, Atlantic Highlands (108).

Geographic distribution.—New Jersey.

Family TURRILITIDAE.

Genus TURRILITES Lamark.

Turrilites pauper Whitfield.

Plate CVIII., Figs. 1–4.

1892. *Turrilites pauper* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 268, pl. 45, figs. 1-5.

Description.—Shell with the coils in close contact, the volutions higher than wide, with a moderately wide umbilical opening in the cast, the living chamber occupying a little more than one full volution; upper edge of the volutions angular externally where they meet the next succeeding volutions above, within the angle the surface in contact with the next volution above is con-

[1] Meek, Inv. Cret. and Ter. Foss. Up. Mo., p. 484, pl. 21, figs. 3 a-c.

cave; the outer and lower surfaces of the volutions rounded; outer surface marked by two rows of nodes nearly equal in prominence, one of them situated near the middle of the height, the other near the lower margin; surface of the volutions marked by oblique, transverse folds or ridges which increase in number by division or intercalation at the upper and lower margins of the outer surface; the ridges are strongly directed forward as they cross the volution from the upper to the lower side, and are even faintly visible within the umbilicus; the nodes in each row are usually present upon alternate ribs, the ribs of the two rows alternating with each other so that nearly every rib has one node in either the upper or the lower row. The suture with a ventral lobe lying between the higher row of tubercles and the upper margin of the outer surface of the shell; it is indented in the middle by a rather broad siphonal saddle; below the ventral lobe the first lateral lobe is very large with four larger divisions; it is nearly bisected by the lower row of tubercles which mark the lower shoulder of the volutions; a second lateral lobe much shallower than the first, but rather broad, is present upon the lower side of the volution just outside the umbilical cavity; the two lower lateral saddles are both broad, the first one being somewhat larger than the second; both are rather deeply bifid with each of the divisions again bifid; above the ventral lobe the lateral lobes and saddles are similar to those below but are smaller; all the lobes and saddles are secondarily indented by tooth-like irregularities.

The dimensions of the type specimen are: diameter of last volution, 29 mm.; height of last volution near the aperture, 16.5 mm.; width of last volution near aperture, 13 mm.

Remarks.—The type specimen of this species retains about one and one-third volutions, the greater portion of which is occupied by the living chamber, only the first suture and a portion of the second being retained. Two other specimens have been observed which are referred to the species with some doubt, both of them are much distorted fragments which differ in some respects from the type but are too imperfect for certain identification.

Formation and locality.—Marshalltown clay-marl, near Swedesboro (177); Wenonah sand, near Marlboro (130[1]); Navesink marl, Navesink Hills (Whitfield, type specimen).

Geographic distribution.—New Jersey.

Family MAMMITIDAE.

Genus BARROISICERAS Gross.

Barroisiceras dentato-carinatus (Rœmer).

Plate CI., Figs. 5-6.

1849. *Ammonites dentato-carinatus* Roem., Texas, p. 417.
1852. *Ammonites dentato-carinatus* Roem., Kreid. von Texas, p. 33, pl. 1, figs. 2 a-c.
1861. *Ammonites dentato-carinatus* Gabb, Synop. Moll. Cret. Form., p. 65 (9).
1864. *Ammonites dentato-carinatus* Meek, Check List Inv. Foss. N. A., Cret and Jur., p. 24.
1892. *Ammonites dentato-carinatus* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 250, pl. 41, figs. 3-4.
1905. *Ammonites dentatocarinatus* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 27.

Description.—"The shell when entire has been compressed discoidal, with a proportionally small umbilicus, the volutions have been sharp on the ventral edge and marked by a series of undulations which gave rise to the specific name. The sides are ornamented by two lines of nodes which divide the surface into three nearly equal spaces, also by transverse ridges which are low and rounded, and pass from the margin of the umbilicus almost directly across the volutions to a node one-third of its breadth from the margin, and are then bent sharply forward, their convexity giving rise to the undulations on the dorsal carination. Some of the ridges bifurcate at the inner line of nodes, each branch reaching the margin as independent ridges, but the fragment is too small to show how frequently this feature occurs." (Whitfield.)

Remarks.—This species is known from New Jersey by a single fragmentary individual preserved in the collection of the Philadelphia Academy of Science. The sutures are very complicated and consist of a large ventral lobe which is deeply divided by a comparatively narrow ventral saddle trifid on top and reaching nearly to the mid-height of the lobe, and three lateral lobes; all the lobes are much complicated by deep and sharp divisions, the divisions of the saddles being more rounded.

Formation and locality.—Unknown, New Jersey (Whitfield).

Geographic distribution.—New Jersey, Texas.

Family PRIONOTROPIDAE.

Genus MORTONICERAS Meek.

Mortoniceras delawarensis (Morton).

Plate CIII., Fig. 1; Plate CIV., Figs. 1–5.

1830. *Ammonites Delawarensis* Mort., Am Jour. Sci., 1st ser., vol. 18, pl. 2, fig. 4.
1830. *Ammonites Vanuxemi* Mort., Am. Jour. Sci., 1st ser., vol. 18, pl. 3, figs. 3-4.
1834. *Ammonites Delawarensis* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 37, pl. 2, fig. 5.
1834. *Ammonites Vanuxemi* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 38, pl. 2, figs. 3-4.
1861. *Ammonites Delawarensis* Gabb, Synop. Moll. Cret. Form., p. 65 (9).
1864. *Ammonites delawarensis* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 24.
1868. *Ammonites delawarensis* Con., Cook's Geol. N. J., p. 730.
1892. *Ammonites Delawarensis* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 252, pl. 42, figs. 6-9, pl. 43, figs. 1-2.
1892. *Ammonites Vanuxemi* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 253, pl. 42, figs. 1-5.
1905. *Ammonites delawarensis* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 27.

1905. *Ammonites vanuxemi* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 27.

Description.—Shell attaining a rather large size when full grown, a large individual in the collection of the Philadelphia Academy of Science having a maximum diameter of over 180 mm.; moderately compressed, subdiscoid in form, with five or six volutions; outer volutions embracing the inner ones a little less than one-half their width; the umbilicus rather broad, the volutions with a distinct umbilical shoulder; the venter flattened with a distinct keel which becomes less prominent with age; the margins of the flattened venter each marked by a row of obliquely elongate nodes which are formed by the extremities of the rounded costæ which cross the sides of the volutions; a row of nodes also marks the inner extremities of the costæ along the margin of the umbilicus, and three other rows occur at nearly equal distances apart between the umbilical and marginal rows; all these markings are more strongly developed upon the younger individuals, becoming more and more faint with increasing age; sides of the volutions in younger individuals nearly flat, or only slightly convex, becoming more strongly convex in older individuals. Septa composed of a large ventral lobe divided medially by a low, truncated siphonal saddle, and three lateral lobes, the middle one of which is much the larger with about five divisions and many serrations; the first lateral lobe is narrow with serrated sides, its depth about one-half that of the ventral lobe; it is really little more than a rather deep and narrow indentation of a broad first lateral saddle; third lateral lobe larger than the first but much smaller than the second; on the dorsal side, at the bottom of the dorsal furrow, is a deep, narrow, serrated dorsal lobe, with two smaller lobes on either side of it between the dorsal line and the umbilical shoulders; the divisions of the saddles much more rounded than those of the lobes.

Remarks.—Whitfield has recognized Morton's two species, *A. delawarensis* and *A. vanuxemi,* as distinct, the chief difference being in the greater compression of *A. vanuxemi* and its smaller size. The two forms occur together in the Merchantville clay-

marl, and the greater compression of *A. vanuxemi* is probably accidental and not of sufficient importance to justify the recognition of distinct species.

Formation and locality.—Merchantville clay-marl, Lenola (163), Burlington (Whitfield).

Geographic distribution.—New Jersey.

Sub-class DIBRANCHIATA.

Order BELEMNOIDEA.

Family BELEMNITIDAE.

Genus BELEMNITELLA d'Orbigny.

Belemnitella americana (Morton).

Plate CIX., Figs. 1–4.

1830. *Belemnites Americanus* Mort., Am. Jour. Sci., 1st ser., vol. 17, p. 281; vol. 18, pl. 1, figs. 1–3.

1830. *Belemnites subconicus* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 99, pl. 5, fig. 7. (Not *B. subconicus* Lam.)

1830. *Belemnites Americanus* Mort., Jour. Acad. Nat. Sci. Phil., 1st ser., vol. 6, p. 192, pl. 8, fig.

1834. *Belemnites Americanus* Mort., Synop. Org. Rem. Cret. Gr. U. S., p. 34, pl. 1, figs. 1, 2, 3, 3 a.

1850. *Belemnitella mucronata* d'Orb., Prod. Paleont., vol. 2, p. 211.

1858. *Belemnitella americana* Emmons, Rep. N. Car. Geol. Surv., p. 246, fig. 101.

1861. *Belemnitella mucronata* Gabb, Synop. Moll. Cret. Form., p. 78 (22).

1864. *Belemnitella paxillosa* Meek, Check List Inv. Foss. N. A., Cret. and Jur., p. 26.

1868. *Belemnitella mucronata* Con., Cook's Geol. N. J., p. 375, figure; p. 731.

1868. *Belemnitella paxillosa* Con., Cook's Geol. N. J., p. 731.

1892. *Belemnitella Americana* Whitf., Pal. N. J., vol. 2 (Monog. U. S. G. S., vol. 18), p. 280, pl. 47, figs. 1–11.

1905. *Belemnitella americana* Johns., Proc. Acad. Nat. Sci. Phil., 1905, p. 28.

Description.—Guard elongate, tapering, sometimes attaining a rather large size, the length of a large individual being 135 mm., with a maximum thickness of 20 mm. Cross-section subtriangular in the larger portion, the ventral side flattened; toward the smaller extremity the cross-section becomes more nearly circular or elliptical, the flattening being in a dorso-ventral direction. The alveolar cavity excavating the guard for about one-third, or somewhat more than one-third, its length, the edge of the guard at the aperture of the alveolus becoming very thin and rarely or never being perfectly preserved; the ventral slit extending nearly to the bottom of the alveolar cavity, not produced beyond that point as a ventral groove. The small end of the guard, when perfectly preserved, is produced in a small mucronate extremity. When not worn the surface is roughened, most conspicuously upon the broad ventral and the narrow dorsal sides towards the larger extremity, there being a comparatively smooth, rather narrow, longitudinal band upon each of the sloping dorso-lateral sides. The phragmocone has not been observed, although casts of the alveolar cavity are common, and occasionally one of them retains the impressions of the septal lines.

Remarks.—This species is, perhaps, the most characteristic member of the Navesink fauna, and has not been observed in any other horizon in New Jersey. It occurs in practically every locality of this formation which is at all fossiliferous, and sometimes occurs in so great abundance that hundreds of individuals can be collected in a small area. Most of the specimens, however, have been more or less worn before they have been buried in the sediments, so that it is rare to find any individual perfectly preserved, most of the very best examples having the thin edge of the alveolar cavity and the mucronate extremity of the shell

destroyed. The species is a very close ally of the European *B. mucronatus* Schl., and the two have frequently been considered as identical. The writer has not had an opportunity to compare the New Jersey specimens with a large suite of European examples, but Whitfield states that such a comparison shows the American examples to be, proportionally, somewhat more elongate, and if this be a constant character the American form is doubtless properly considered as a distinct species. The specimens vary greatly in size and the smaller ones are usually proportionately more slender than the larger ones. It is also frequently the case that at any one locality there is not a great variation in size, an assortment which may be due to the transportive power of the water at the time of deposition.

Formation and locality.—Navesink marl, Atlantic Highlands (108), Middletown (113[2]), near Crawfords Corner (126[7]), near Holmdel (128[3], 128[5], 127, 194), Marlboro (131), near Freehold (133), near Walnford (148[2]), Crosswicks Creek (149, 147[2], 147[3], 147[4], 195), near Jacobstown (150), near Mount Laurel (166), Mullica Hill (169[2]).

Geographic distribution.—New Jersey, Delaware, North Carolina, Alabama, Mississippi, Texas.

CHAPTER VI.

Branch ARTHROPODA.

Class CRUSTACEA.

Sub-class EUCRUSTACEA.

Super-order OSTRACODA.

Family CYTHERIDAE.

Genus CYTHEREIS Jones.

Cythereis bassleri Ulrich.

Plate CX., Figs. 1–3.

1901. *Cythereis bassleri* Ulr., Md. Geol. Surv., Eocene, p. 117, pl. 16, figs. 5–8.

Description.—"Carapace oblong, length 0.80 to 0.85 mm., widest and rounded anteriorly; the posterior edge more or less angular in the middle, straight or slightly sinuate above to the angular extremity of the hinge, and with two or three spines projecting from the slightly convex, lower half; edges with a thickened rounded rim, becoming obsolete near the center of the flattened ventral region; hinge line straight, except at the antero-cardinal angle, which is thickened and prominent; ventral outline slightly sinuate. Valves equal, with a rounded subcentral node, sometimes obscured by a network of small ridges, and a sharp ventral ridge rising gradually from its inception at the antero-ventral angle and ceasing abruptly at a point about one-fourth of the length of the valve from its posterior extremity. A less prominent ridge runs from the high end of the ventral ridge in a slightly oblique direction, to the post-cardinal angle and then turns forward. The whole surface is covered

with rather large pits arranged in more or less irregular curved series, the space between the rows, especially over the central portion of the valves, being raised into thin and sometimes coalescing ridges." (Ulrich).

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey; also Eocene of Maryland.

Family CYPRIDAE.

Genus BYTHOCYPRIS Brady.

Bythocypris parilis Ulrich.

Plate CX., Figs. 4–7.

1901. *Bythocypris pariles* Ulr., Md. Geol. Surv., Eocene, p. 117, pl. 16, figs. 5–8.

Description.—"Carapace about 1.0 mm. long and nearly or quite 0.5 mm. high; reniform, strongly arched dorsally, very slightly sinuate or straight in the ventral portion of the outline, and with the ends rounded and very nearly equal, the posterior outline, however, being usually a trifle oblique above, and the turn into the basal line slightly lower than at the front end; point of greatest thickness above the middle, the slope toward the ventral edge being flatter than elsewhere; edge view elongate, subelliptical, the anterior extremity more acute than the posterior, the latter being comparatively blunt. Left valve slightly overlapping the right both above and below, its ventral edge somewhat thickened in the middle and bordered along the anterior and posterior thirds of its extent by a sharply impressed, thin line. Surface generally appearing quite smooth, but under favorable circumstances very small scattered punctæ may be observed. Interior of valves with the marginal plate well developed and widest in front." (Ulrich.)

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey; also Eocene of Maryland.

Family CYTHERELLIDAE.

Genus CYTHERELLA Jones.

Cytherella submarginata Ulrich.

Palte CX., Figs. 8–9.

1901. *Cytherella submarginata* Ulr., Md. Geol. Surv., Eocene, p. 118, pl. 16, figs. 14–15.

Description.—"Carapace about 1.0 mm. in length, somewhat oblong, rounded at the ends, the posterior end a little wider and its margin more oblique above and merging more gradually into the very slightly arcuate dorsal outline than the anterior; ventral margin straight, edge view subcuneiform, end view subovate, Valves compressed convex, thickest posteriorly, with an obscurely defused broad depression near the midlength and mostly above the center of the valves. A narrow but distinct rim borders the two ends. Surface smooth." (Ulrich.)

Remarks.—This species described from the Eocene of Maryland is sometimes met with in washings from the Vincentown limesand.

Formation and locality.—Vincentown limesand, Vincentown (154).

Geographic distribution.—New Jersey; also Eocene of Maryland.

Super-order CIRRIPEDIA.

Order THORACICA.

Family LEPADIDAE.

Genus SCALPELLUM Leach.

Scalpellum conradi Gabb.

Plate CX., Fig. 10.

1876. *Scapellum Conradi* Gabb, Proc. Acad. Nat. Sci. Phil. (1876), p. 179, pl. 5, figs. 3–3b, 4.

1905. *Scalpellum conradi* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 28.

Description.—"The scutal plate is nearly straight on its occludent margin; the tergal margin is strongly sloping and a little concave at the apical portion; the base is straight, or very slightly convex. The surface is slightly angulated, and marked by strong lines of growth."

"The carina is large, indicating a size of about an inch and a half in length of the animal, without the stem. It has nearly straight sides, is very gently curved; external surface nearly flat at the upper part and rounded subangular below in the median line. Upper end acute, base rounded; inner face deeply concave; sides bearing a prominent linear rib, which marks the three parts of the surface into which Darwin divides this plate." (Gabb).

Remarks.—The detached plates of this cirriped are sometimes met with in the washings from the Vincentown limesand at Vincentown, and from the same formation at other localities. It is, however, one of the rare species of the fauna.

Formation and locality.—Vincentown limesand, Vincentown (154), near Hurffville (170).

Geographic distribution.—New Jersey.

Sub-class MALACOSTRACA.

Order DECAPODA.

Sub-order MACRURA.

Family ASTACIDAE.

Genus HOPLOPARIA McCoy.

Hoploparia gabbi Pilsbry.

Plate CX., Figs. 12–15.

1901. *Hoploparia gabbi* Pilsbry, Proc. Acad. Nat. Sci. Phil. (1901), p. 115, pl. 1, figs. 11–14.

1905. *Hoploparia gabbi* Johns., Proc. Acad. Nat. Sci. Phil. (1905), p. 28.

Description.—"Right propodite robust, evenly convex on both sides, but slightly more convex above than below, surface slightly roughened everywhere by small flattened, separated, scale-like asperities; lower margin bluntly angular and marked by a slight groove; upper margin narrowly rounded, bearing a couple of short conic spines, inserted slightly below the edge and directed downward and forward; on each side there is a rounded tubercle at the base of the dactylopodite. Fixed finger rather slender, with a series of coarse tubercles (worn flat) along its grasping edge. Dactylopodite armed with a short conic spine near its base (continuing the row of similar spines on the upper margin of the propodite), its grasping face with a series of coarse tubercles, worn flat. Carpopodite (?) irregularly cylindrical, gibbous, a little compressed and faintly grooved along the outer side, bearing a series of several short spines along the inner. Abdominal somites with highly arched tergum, the surface punctate." (Pilsbry.)

Remarks.—"This species is based upon a right hand and group of four abdominal somites in the collection of the Academy of Natural Sciences of Philadelphia, and a right hand and carpopodite (?) in that of the Wagner Free Institute. The fixed finger is broken in both specimens, and the proximal portion of the hand is wanting. In the Wagner Institute specimen the base of the dactylopodite remains.

A much smaller propodite from Monmouth County, N. J., shows a series of four short spines along the upper margin; but, perhaps, this specimen belongs to an allied but distinct species, as it is much less convex inside than the larger claws. In the large specimens from Lenola only the anterior two spines remain, as described above, owing to the loss of the posterior portion of the hand.

On account of the mutilated condition of the remains, measurements cannot readily be given, but an Astacoid somewhat larger than the common eastern crayfish is indicated. The figures are of natural size. The high arch of the abdomen may be partly due to lateral compression. Until further remains come to light, and especially the cephalothorax, the generic position of the species will be uncertain." (Pilsbry.)

Formation and locality.—Merchantville clay-marl, Lenola (163).

Geographic distribution.—New Jersey.

Hoploparia gladiator Pilsbry.

Plate CX., Figs. 16–17.

1901. *Hoploparia gladiator* Pilsbry, Proc. Acad. Nat. Sci. Phil. (1901), p. 116, pl. 1, figs. 15–16.

Description.—"Propodite long and narrow, parallel-sided, its thickness more than half the width, about equally convex on the two sides, smoothish, showing scattered punctures and under a lens a very fine punctulation; on both sides of the hand a row of three or four small pointed tubercles run lengthwise along the median convexity; lower edge bluntly biangular. Fixed finger nearly double the width of the dactylopodite, pyriform in section, with a row of tubercles along the grasping edge. Dactylopodite oval in section, also bearing pointed tubercles opposed to those on the fixed finger.

Length of propodite as broken, 35 mm.; width, 11.5 mm.; thickness, 7 mm." (Pilsbry.)

Remarks.—"Types are No. 10,120 Coll. Wagner Free Institute of Science, and consist of an imperfect propodite with broken dactylopodite in place, a fragment of the fixed finger, apparently of the same specimen, and a fragment of another hand of larger size, width 14 mm., thickness 9 mm. They were exposed by breaking hard nodules which occur in the clay at Lenola. Another broken propodite is in the collection of the Academy from the deep cut of the Chesapeake and Delaware canal, in Delaware.

The species is readily recognizable by the long, narrow shape of the hand and the minute punctulation of the surface, the biangulate lower edge of the fixed finger and hand, etc. It can hardly be the smaller chela of *H. gabbi* on account of the different surface sculpture, etc." (Pilsbry.)

Formation and locality.—Merchantville clay-marl, Lenola (163).

Geographic distribution.—New Jersey.

Family THALASSINIDAE.

Genus CALLIANASSA Leach.

Callianassa mortoni Pilsbry.

Plate CXI., Figs. 1–15.

1901. *Callianassa mortoni* Pilsbry, Proc. Acad. Nat. Sci. Phil. (1901), p. 112, pl. 1, figs. 1–7.
1905. *Callianassa mortoni* Johns, Proc. Acad. Nat. Sci. Phil. (1905), p. 28.

Description.—"Propodite rhombic, its breadth about two-thirds the length, the outer face very convex, the greatest convexity posterior and nearer the upper side. Surface nearly smooth, usually showing a series of four distinct punctures extending backward from the root of the fixed finger, and two on the other or more convex side; *the posterior margin abruptly falling* near the joint, a prominence bearing a group of small tubercles at the summit before the deflection. Inner surface of palm much less convex, becoming concave near the lateral margins, nearly smooth, the anterior margin slightly excavated between the root of the fixed finger and the dactylopodite, and bordered there with a short row of small tubercles. On the median portion of the palm there are two punctures, marking it off into thirds longitudinally. Lateral margins of the propodite acute, closely, finely and regularly crenulate; the lower margin straight, with a row of punctures along the inner side but extremely near the edge, and another close to the edge outwardly; upper margin deeply curved down posteriorly, produced into a deflexed lobe and similarly margined with spaced punctures. Fixed finger about one-third the total length of the whole propodite, curved at the tip, finely crenate along the grasping margin when unworn, and with a blunt median tooth. Dactylopodite with two contiguous crenulate carinæ along its outer edge. Carpopodite somewhat shorter than the palmer surface of the propodite, equally convex inside and out, turgid anteriorly, its outer face with an oblique groove bordered with small tubercles near the distal lower angle. Posterior

upper angle produced backward in a rather slender process. Meropodite subtriangular in section, the upper keel strongly arched, lower keel nearly straight and more strongly serrate, the middle of the very convex outer surface granulose, with two rounded tubercles at the anterior extremity; the opposite or inner face nearly flat. In all specimens preserved with the members in place, the meropodite is flexed at a right angle with the carpopodite." (Pilsbry.)

The dimensions of a propodite are: length, 25 mm.; length, exclusive of finger, 18 mm.; width in the middle, 11 mm.; thickness, 6 mm.; the dimensions of another specimen are: length, exclusive of finger, 29 mm.; width in the middle, 19 mm.; thickness, 9.5 mm.; the dimensions of a carpopodite are: greatest length, measured obliquely 20 mm.; length from middle of distal to middle of proximal margin, 14 mm.; width in the middle, 12 mm.; length of a meropodite, 13 mm.

Remarks.—"What *Callianassa faujasi* is in Europe to the Maestrichtien, *C. mortoni* is on this side of the Atlantic to the "Lower Marl" beds. It is an abundant species, known by remains of over one hundred individuals, chiefly the propodites only, though sometimes the meropodite, carpopodite and propodite are preserved in place; when this is the case, it is usually due to their being more or less imbedded in hard nodules. The abrupt deflection of the hind margin of the more convex face of the propodite, and the downward bend, posteriorly, of its upper margin are characteristic of the species.

Both chelæ of a Lenola individual preserved in one nodule show the right claw to be somewhat the larger. Otherwise the two claws seem to be counterparts. I can find no other difference.

The largest specimens show a shallow, vermiculate wrinkling of the surface, but the smaller are almost smooth to the eye or touch. The crenulation of the margins becomes stronger with age, and is occasionally lost or obscured by chipping of the edges." (Pilsbry.)

Formation and locality.—Merchantville clay-marl, Lenola (163); Navesink marl, near Walnford (148^2), Crosswicks Creek

(149, 195), near Jacobstown (150); Tinton beds, Tinton Falls (110), Beers Hill cut, south of Keyport (129^7, 129^9), near Freehold (132).

Geographic distribution.—New Jersey.

Callianassa conradi Pilsbry.

Plate CX., Figs. 18–22.

1901. *Callianassa conradi* Pilsbry, Proc. Acad. Nat. Sci. Phil. (1901), p. 114, pl. 1, figs. 8–10.

Description.—"Propodite rhombic, its length (without finger) not much exceeding the width, somewhat more convex on the outer than on the inner face, *the posterior margin neither abruptly nor deeply deflexed.* Surface smoothish, with some small tubercles on each side of the slight excavations on both sides of the hand near the commissure between the bases of the fingers; the acute lateral edges crenulate, as in *C. mortoni,* but the lower edge is not deflexed posteriorly as in that species. *Fixed finger triangular in section,* the angles crenulated, the flat, grasping face with a short smooth rib near the base, which joins the keel along the outer angle of the finger." (Pilsbry.)

The dimensions of a propodite are: length, about 30 mm.; length, exclusive of the finger, 18.5 mm.; width, 16.5 mm.; thickness, 7.6 mm.

Remarks.—"The claw of *C. conradi* differs from that of *C. mortoni* in being much shorter and broader; more evenly convex on the two sides, the posterior margin of the outer side and the keel along the upper edge are not abruptly deflexed behind; the fixed finger of the propodite of *C. conradi* has no median tooth on its grasping face, which is flat, with a short, smooth ridge and bounded by two crenulate angles, while in *C. mortoni* there is a median tooth, a crenulate ridge on the face, and no crenate angle along the lower inner part of the finger." (Pilsbry.)

Formation and locality.—Tinton beds, Tinton Falls (110), Beers Hill cut (129^9).

Geographic distribution.—New Jersey.

Sub-order BRACHYURA.

Family DROMIACAE

Genus TETRACARCINUS Weller.

Tetracarcinus subquadratus Weller.

Plate CXI., Figs. 16–19.

1905. *Tetracarcinus subquadratus* Weller, Jour. Geol., vol. 13, p. 328, figs. 4–6.

1905. *Tetracarcinus subquadratus* Weller, Geol. Surv. N. J., Ann. Rep. State Geol. for 1904, p. 136, pl. 15, figs. 4–6.

Description.—Carapace subquadrangular, length and breath nearly equal, the dimensions of two individuals are: length, 12.3 mm. and 14.4 mm.; breadth, 12.5 mm., and 14 mm. Dorsal surface convex longitudinally and transversely, the sides curving abruptly downward to a nearly vertical position, marked by two longitudinal and two transverse furrows. Rostrum short, with a deep, longitudinal, median furrow. Extending backward from the posterior extremity of the median furrow of the rostrum, the two longitudinal dorsal furrows diverge from their anterior point of origin to the junction with the anterior transverse furrow, and then converge until they nearly meet again at the posterior margin of the carapace, enclosing a longitudinal, median area, which is not crossed by the anterior transverse furrow, and across which the posterior transverse furrow is less strongly defined than in its lateral limbs. The lateral limbs of the transverse furrows become less well defined towards the margin of the carapace, the anterior ones curve slightly backward toward their distal extremities, while the posterior ones have a slight forward curve, so that the two together, with the longitudinal furrows, enclose a pair of slightly convex, subovate areas. From the antero-lateral margins of each of these subovate areas two slight, gently curved tuberculose ridges or lines

of tubercles extend forward, diverging slightly, to the antero-lateral margins of the carapace.

Remarks.—The type specimens of this species, illustrated with the original description of the species, are three in number, two of them being from the Cliffwood clay at Cliffwood Point, and the third from the Woodbury clay at Lorillard.

Formation and locality.—Cliffwood clay, Cliffwood Point (105), near Matawan (189). Woodbury clay, Lorillard (102).

Geographic distribution.—New Jersey.

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